AD-A063 366 GEORGIA UNIV BRUNSWICK MARINE EXTENSION SERVICE F/G 13/2

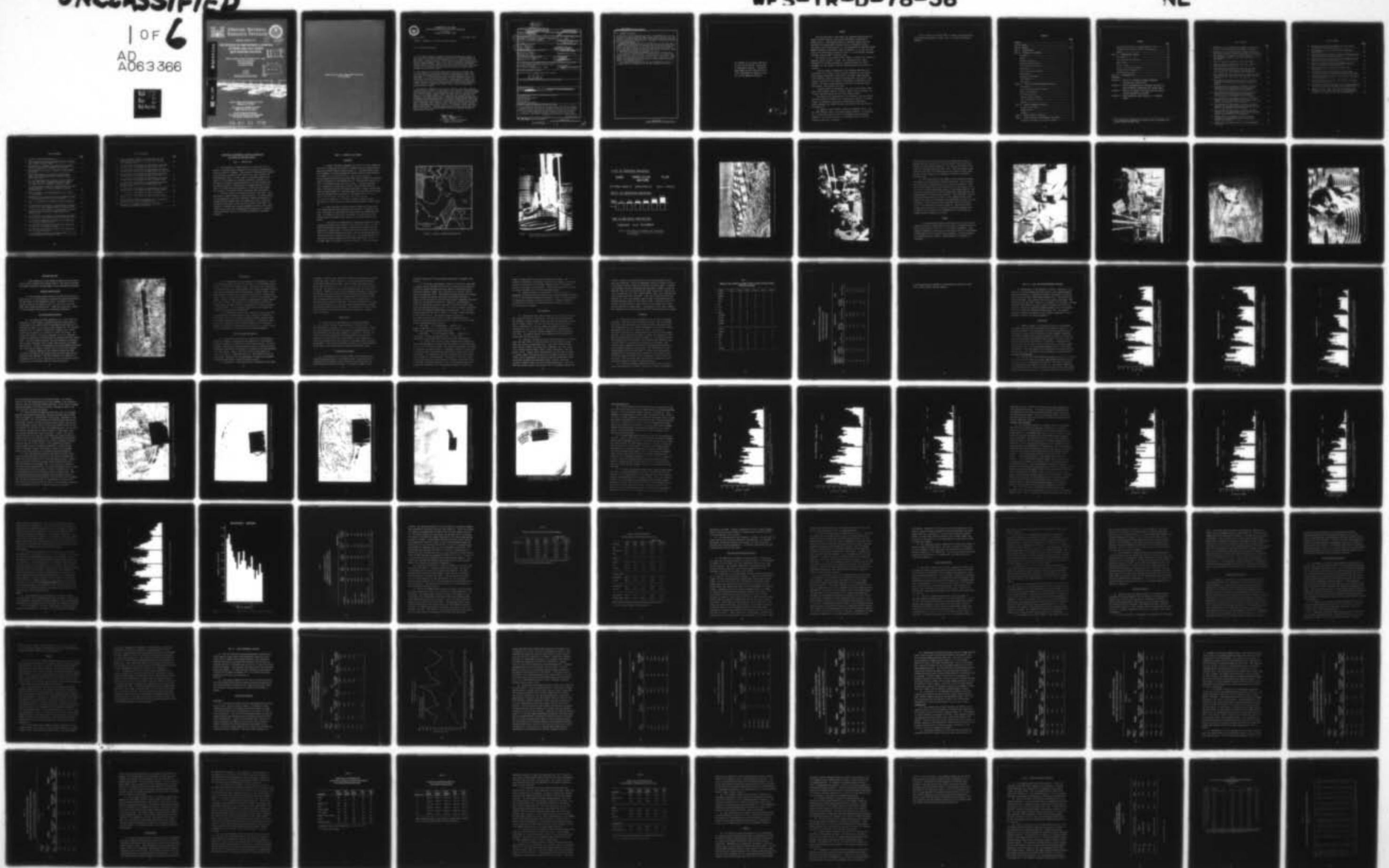
THE EFFECTS OF SMOTHERING A 'SPARTINA ALTERNIFLORA' SALT MARSH --ETC(U)

JUL 78 R J REIMOLD, M A HARDISKY, P C ADAMS DACW21-75-C-0074

UNCLASSIFIED WES-TR-D-78-38 NL

1 OF 6

AD
A063366



LASSIFI

1 OF 6

AD
A063366

DREDGED MATERIAL RESEARCH PROGRAM

TECHNICAL REPORT D-78-38

THE EFFECTS OF SMOTHERING A SPARTINA ALTERNIFLORA SALT MARSH WITH DREDGED MATERIAL

by

Robert J. Reimold, Michael A. Hardisky, Patrick C. Adams
Marine Extension Service
University of Georgia
Brunswick, Ga. 31520

July 1978

Final Report

Prepared for Office, Chief of Engineers, U. S. Army
Washington, D. C. 20314

Under Contract No. DACW21-75-C-0074
(DMRP Work Unit No. 2A07)

Monitored by Environmental Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

Destroy this report when no longer needed. Do not return it to the originator.

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
P. O. BOX 631
VICKSBURG, MISSISSIPPI 39180

IN REPLY REFER TO: WESEV

30 September 1978

SUBJECT: Transmittal of Technical Report D-78-38

TO: All Report Recipients

1. The technical report transmitted herewith represents the results of Work Unit 2A07 regarding experimental deposition of dredged material on salt marsh. This work unit was conducted as part of Task 2A (Effects of Marsh and Terrestrial Disposal) of the Corps of Engineers' Dredged Material Research Program (DMRP). Task 2A was a part of the Habitat Development Project (HDP) of the DMRP and was concerned with the definition and quantification of the effects of dredged material disposal on shallow water, wetland, and terrestrial sites.

2. The purpose of this research (Work Unit 2A07) was to evaluate the recovery response of salt marsh vegetation to deposition of sand, sandy clay, and clay dredged material at various depths between 8 and 91 cm. The results of this study indicate that it may be possible to alter the elevations of a marsh through disposal of dredged material without loss of the functional values of that system. This research is largely conceptual in nature and has not been extensively field tested; application of this study to a large-scale disposal project should be approached with particular caution.

3. The specific findings of this study are distinct from other research conducted within the HDP, and the concept of the recovery of marsh smothered with dredged material is not addressed in other studies. Generally related work units are 4A04A1, 4A04A2, 4A04B, and 4A05, each of which deal with aspects of salt marsh productivity. Supportive and comparative data are available in Synthesis Report DS-78-15 entitled "Upland and Wetland Habitat Development with Dredged Material: Ecological Considerations" (2A08), and in the analysis of the results of field studies at Windmill Point, Virginia (4A11); Buttermilk Sound, Georgia (4A12); Apalachicola, Florida (4A19); Bolivar Peninsula, Texas (4A13); Pond No. 3, California (4A18); and Miller Sands, Oregon (4B05). Together these research products will provide the Corps with a basis for sound management decisions regarding disposal in marsh-estuarine systems.

JOHN L. CANNON
Colonel, Corps of Engineers
Commander and Director

(18) WES

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER (19) TR-
Technical Report D-78-38

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER
(9)

4. TITLE (and Subtitle) (6)
THE EFFECTS OF SMOTHERING A SPARTINA ALTERNIFLORA SALT MARSH WITH DREDGED MATERIAL.

5. TYPE OF REPORT & PERIOD COVERED
Final report,

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s) (10)
Robert J. Reimold,
Michael A. Hardisky
Patrick C. Adams

8. CONTRACT OR GRANT NUMBER(s)
Contract No.
(15) DACW21-75-C-0074

9. PERFORMING ORGANIZATION NAME AND ADDRESS
University of Georgia
Marine Extension Service
Brunswick, Ga. 31520

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
DMRP Work Unit No. 2A07

11. CONTROLLING OFFICE NAME AND ADDRESS
Office, Chief of Engineers, U. S. Army
Washington, D. C. 20314

12. REPORT DATE
(11) July 1978

13. NUMBER OF PAGES
483

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)
U. S. Army Engineer Waterways Experiment Station
Environmental Laboratory
P. O. Box 631, Vicksburg, Miss. 39180

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Approved for public release; distribution unlimited.

(12) 487p.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES
Appendices A through D to this report [redacted] are included [redacted] inside the back cover.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Dredged material
Dredged material disposal
Marsh development
Salt marshes
Vegetation establishment

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A study of the capability of high salt marsh to recover from disposal of dredged material indicates that smothering high marsh could be a feasible disposal alternative but should be used with caution and should only be employed when other alternatives are economically or physically infeasible.

The study investigated the impact of smothering short form *Spartina alterniflora* in Glynn County, Georgia, with three types of dredged material

(Continued)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

410600 79 01 15 020

20. ABSTRACT (Continued).

(coarse sand, sand and clay mixed, and clay), at six depths (8, 15, 23, 30, 61, and 91 cm), and at different stages of plant growth (February, July, and November). Corrugated metal pipes (0.9-m diam) were sunk into the marsh and used as containers for dredged material. The impact of disposal was evaluated over two growing seasons.

Spartina alterniflora was able to penetrate up to 23 cm of each type of dredged material and exhibited biological growth and production nearly equal to that in undisturbed marsh. These depths, being within the elevational range of the marsh, indicate that accurate tidal and elevational data should be collected before disposal on a marsh and that deposition should not exceed the elevational limit of the existing marsh.

The study also ~~included an assessment of~~ assessed the impact of smothering on selected species of crabs and snails. Crabs were able to recolonize areas covered with up to 23 cm of clay dredged material and 15 cm of sand. Snails rapidly recolonized material placed 8 and 15 cm deep. Faunal recovery may depend on the proximity of the disposal area to natural populations and the extent of the smothered areas.

While smothering operations can offer an alternative to disposal, the technique cannot be considered proven and must be approached with care.

THE CONTENTS OF THIS REPORT ARE NOT TO BE USED FOR ADVERTISING, PUBLICATION, OR PROMOTIONAL PURPOSES. CITATION OF TRADE NAMES DOES NOT CONSTITUTE AN OFFICIAL ENDORSEMENT OR APPROVAL OF THE USE OF SUCH COMMERCIAL PRODUCTS.

PREFACE

The work described in this report was conducted under Contract No. DACW21-75-C-0074 entitled, "Buttermilk Sound Habitat Development," between the U. S. Army Engineer District, Savannah, Georgia, and the University of Georgia Marine Extension Service, Brunswick, Georgia. The research was conducted as part of the Dredged Material Research Program (DMRP) sponsored by the Office, Chief of Engineers, U. S. Army, and monitored by the Environmental Laboratory (EL), U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss.

The authors of the report were Dr. Robert J. Reimold, Mr. Michael A. Hardisky, and Mr. Patrick C. Adams. Mrs. Kathy Smith, Mr. James Kowalchuck, Ms. Christine Langner, Mr. Stephen Pittman, Ms. Susan Gallagher, Mr. Ray Chauncey, and Mrs. Brenda Tillman assisted with the research.

A sincere thanks is expressed to the following individuals who contributed their efforts to the successful completion of the project: Dianne Adams, Roland Baker, Nancy Bevan, Lori Cobb, Joseph Hardisky, Jo Ann Hardisky, Barbara Harrington, William Harris, Bill Herrin, Pete Johnson, Tim Leftwich, Tom Lindsey, Grady McNure, Carnel Mosely, Tony Moseley, Joey Payne, Thomas Pearson, Brenda Sailors, Milledge Smith, James Vernon, and Professor Paul Wolf.

A special thanks is expressed to the crew of the R/V CAPT GENE, Capt. James "Diddley" Higgins, and Capt. Thomas "Frito" Shierling, and to Capt. David Harrington for use of the research vessel.

The support and contributions of the University of Georgia Marine Extension staff were essential for conducting the research. Dr. Wayne Bough, Jill Edmundson, Donna Hinton, Rowena Kelly, Donna Sloop, Beverly Hardisky, and Amanda Harrison assisted with the preparation of the manuscript.

Dr. Hanley K. Smith, Manager, Habitat Development Project, and Dr. John Harrison, Chief, EL, provided general guidance. EL scientists Dr. J. Scott Boyce and Dr. Carlos H. Pennington served as Contract Managers. Mr. William Clarkson of the Savannah District provided assistance and advice throughout.

COL G. H. Hilt, CE, and COL John L. Cannon, CE, were Directors of WES during the period of study. Mr. F. R. Brown was Technical Director.

CONTENTS

	Page
PREFACE	ii
LIST OF TABLES	vi
LIST OF FIGURES	viii
PART I: INTRODUCTION	1
PART II: MATERIALS AND METHODS	2
Treatments	2
Design	8
Enclosure Controls	13
Adjacent Marsh Controls	13
3m x 3m Enclosure Controls	13
Culm Density	15
Live Crabs and Crab Burrows	15
Marsh Snails	16
Standing Crop Biomass	16
Soil Chemistry	18
Elevation	19
PART III: PLANT AND MACROINVERTEBRATE RESPONSE	23
Culm Density	23
Live Crab and Crab Burrow Density	48
Marsh Snail Density	50
Enclosure Controls	52
Adjacent Marsh Controls	53
3m x 3m Enclosure Controls	54
Summary	55
PART IV: PLANT PERFORMANCE (BIOMASS)	57
Standing Crop Biomass	57
Biomass Models	70
Summary	76
PART V: DREDGED MATERIAL CHEMISTRY	79
PART VI: PLANT INVASION OF EXPERIMENTAL ENCLOSURES	93
Invading Plant Species by Enclosure Height	93

CONTENTS

	Page
Invading Plant Species by Dredged Material Type..........	97
Invading Plant Species by Month of Smothering............	98
Summary..	99
PART VII: COMPREHENSIVE SUMMARY..........................	101
Culm Density...	101
Live Crabs and Crab Burrows..............................	101
Marsh Snails...	102
Control Areas..	103
Spartina Alterniflora Biomass..........................	103
Dredged Material Chemistry...............................	105
Invading Plant Species...................................	106
PART VIII: RECOMMENDATIONS...............................	108
REFERENCES...	112
APPENDIX A: ANALYSIS OF VARIANCE FOR MARSH SMOTHERING ENCLOSURE AND CONTROL AREAS*	
APPENDIX B: GRAPHIC REPRESENTATION OF DEPENDENT VARIABLES FOR MARSH SMOTHERING EXPERIMENTAL AND CONTROL AREAS*	
APPENDIX C: ANALYSIS OF VARIANCE FOR BIOMASS AND CULM DENSITY IN MARSH SMOTHERING ENCLOSURES*	
APPENDIX D: MARSH SMOTHERING PLANT INVASION 2 X 2 FREQUENCY TABLES*	

*** This appendix was reproduced on microfiche and is included in an envelope inside the back cover.**

LIST OF TABLES

Page

1. Frequency of tidal inundation in number of events per month for marsh smothering experimental inclosures........ 20
2. Average vertical consolidation of dredged material ten days after placement in marsh smothering in enclosures.... 21
3. Significance of treatments from the analysis of variance for dependent variables in the marsh smothering enclosures.. 44
4. Means of measured variables by enclosure height........... 46
5. Means of measured variables by soil type, month of smothering and enclosure type............................ 47
6. Marsh smothering experimental enclosures estimated combined live and dead standing crop biomass and and culm density from permanent 0.05 m^2 quadrats.......... 58
7. Marsh smothering control enclosures estimated standing crop biomass and culm density from permanent 0.05 m^2 quadrats.. 61
8. Marsh smothering adjacent marsh controls estimated standing crop biomass and culm density from 0.05 m^2 quadrats 62
9. Marsh smothering experimental enclosures estimated combined live and dead standing crop biomass and culm density from permanent 0.05 m^2 quadrats............ 63
10. Marsh smothering experimental enclosures estimated combined live and dead standing crop biomass and culm density from permanent 0.05 m^2 quadrats......... 65
11. Marsh smothering experimental enclosures estimated combined live and dead standing crop biomass and culm density from permanent 0.05 m^2 quadrats.................. 66
12. Marsh smothering experimental enclosures estimated combined live and dead standing crop biomass and culm density from permanent 0.05 m^2 quadrats................. 68
13. Marsh smothering experimental enclosures estimated combined live and dead standing crop biomass and culm density from permanent 0.05 m^2 quadrats................. 69
14. Significance of treatments from the analysis of variance for biomass measurements in the marsh smothering enclosures.................................. 72
15. Biomass and culm density means for marsh smothering enclosures.. 73

LIST OF TABLES

Page

16. Biomass and culm density means by soil type, month of smothering and enclosure type........................ 75

17. Dredged material sieve analysis marsh smothering experimental.. 80

18. Physical analysis and marsh controls and dredged material substrates for marsh smothering site................... 81

19. Mineral analysis of marsh controls and dredged material substrates for marsh smothering stie................... 82

20. Physical properties of the three dredged materials used in the marsh smothering project................... 84

21. Marsh smothering soil moisture, salinity, and temperature.. 85

22. Available nitrogen and phosphorus of three types of dredged material used in marsh smothering enclosures. 87

23. Chemical analysis of composite cores taken in the marsh smothering enclosures................................ 89

24. Mineral content of composite cores taken in the marsh smothering enclosures................................ 90

25. Cumulative speices composition list for marsh smothering experimental enclosures November 1976- November 1977.... 95

26. Summary of marsh plant, snail and crab recovery from different depths, times and types of dredged material deposited on a short *Spartina alterniflora* marsh........ 109

LIST OF FIGURES

		Page
1.	Location of marsh smothering site........................	3
2.	Each enclosure was measured during insertion to ensure proper height above the marsh...........................	4
3.	Description of treatments and illustration of experimental enclosures after placement in the marsh...........	5
4.	Marsh smothering site after placement of experimental enclosures..	6
5.	Sand dredged material was collected with buckets, dumped into drums and shuttled to research vessel with a small boat.....................................	7
6.	The clay dredged material disposal site was inundated by daily high tides. Dredged material was loaded on a small boat for transport to research vessel.........	9
7.	Off loading drums filled with dredged material from the research vessel to a truck for transport to marsh smothering site..	10
8.	Manual dumping of clay dredged material into a small 23 cm enclosure..	11
9.	Smothering a 61 cm enclosure with clay dredged material. No culms exceeded the top of the enclosure..............	12
10.	3 m x 3 m enclosure area adjacent to marsh smothering site..	14
11.	*S. alterniflora* culm density in experimental enclosures smothered with sand dredged material in February 1976....	24
12.	*S. alterniflora* culm density in experimental enclosures smothered with sand and clay dredged material in February 1976..	25
13.	*S. alterniflora* culm density in experimental enclosures smothered with clay dredged material in February 1976....	26
14.	*S. alterniflora* recovery four months after smothering with sand and dredged material..........................	28
15.	*S. alterniflora* recovery four months after smothering with sand and clay dredged material.....................	29
16.	*S. alterniflora* recovery four months after smothering with clay dredged material.............................	30
17.	*S. alterniflora* recovery as of November 1976 in a 15 cm enclosure smothered in February 1976....................	31

LIST OF FIGURES

		Page
18.	A 61 cm enclosure filled in February 1976 with clay dredged material showed no *S. alterniflora* recovery as of November 1976	32
19.	*S. alterniflora* culm density in experimental enclosures smothered with sand dredged material in July 1976	34
20.	*S. alterniflora* culm density in experimental enclosures smothered with sand and clay dredged material in July 1976.	
21.	*S. alterniflora* culm density in experimental enclosures smothered with clay dredged material in July 1976	35
22.	*S. alterniflora* culm density in experimental enclosures smothered with sand dredged material in November 1976	38
23.	*S. alterniflora* culm density in experimental enclosures smothered with sand and clay dredged material in November 1976	39
24.	*S. alterniflora* culm density in experimental enclosures smothered with clay dredged material in November 1976	40
25.	*S. alterniflora* culm density in control enclosures	42
26.	*S. alterniflora* culm density in adjacent marsh control areas	43
27.	Live and dead standing crop biomass for *S. alterniflora* marshes adjacent to marsh smothering site	59
28.	Occurrence of invading plant species with marsh smothering experimental enclosures	94

THE EFFECTS OF SMOTHERING A SPARTINA ALTERNIFLORA SALT MARSH WITH DREDGED MATERIAL

PART I: INTRODUCTION

1. The spreading of dredged material in a thin layer on the surface of existing coastal wetlands is a potentially environmentally compatible method of disposal. This method of dredged material disposal would provide an alternative that could be both cost effective and environmentally sound. In some areas, no acceptable disposal site exists in close proximity to dredging operations, therefore it is necessary to transport dredged materials to a distant disposal area. The time and expense of transporting the dredged material could be saved if a nearby marsh was smothered to a depth that would permit full recovery of the marsh within a relatively short time period.

2. Coastal areas are increasingly utilized by the public, thus generating a renewed interest in their protection. As public pressure for environmentally sound and economically feasible alternatives to dredged material disposal grow, the manager must have a variety of documented alternatives so that the best decision can be made. The aesthetic, ecological and economic standards set forth by the coastal citizens can only be met by possessing the technology for a number of sound alternatives such as the controlled smothering of existing wetlands.

PART II: MATERIALS AND METHODS

Treatments

3. A high, intertidal, homogenous *Spartina alterniflora* marsh was selected to investigate the effects of various layers of dredged material placed on existing coastal wetlands (Figure 1). Corrugated metal pipes, 0.9 m diameter, of various lengths were inserted into the marsh substrate to a depth of 1.2 m in February 1976. The 1.2 below the marsh surface ensured that only the enclosed marsh plants, animals, and substrate would be influenced by the dredged material. The pipes were placed such that a 1-m walkway was available on all sides. A dragline equipped with a modified pile driver was utilized to push the pipes into the marsh. Each pipe was measured during installation to insure proper height above the marsh (Figure 2). The metal pipes were placed in such a fashion that they extended above the surface of the marsh 8 cm (3 in.), 15 cm (6 in.), 23 cm (9 in.), 30 cm (12 in.), 61 cm (24 in.) and 91 cm (36 in.) (Figure 3). The various container heights provided the effect of a dike for each of the six different height classes (Figure 4).

4. Three replicates of each enclosure height were filled with each dredged material type in February and July 1976. In November 1976 only 2 replicates of each height were filled with each dredged material type. The purpose of this was to investigate the seasonal effects of dredged material disposal on the surface of an already existant salt marsh.

5. Three types of dredged material frequently encountered during dredging operations in the southeast were selected for study. A coarse sand from Buttermilk Sound, Georgia, a sand and clay mixture from the Darien River, Georgia and a clay from Jekyll Creek, Georgia, were most typical of dredged sediments of the area. Each of the dredged materials was collected from an existing disposal site. The dredged material was collected in buckets, dumped into 208-ℓ drums and hoisted onto the R/V Capt. Gene for transport to the dock (Figure 5). The clay dredged

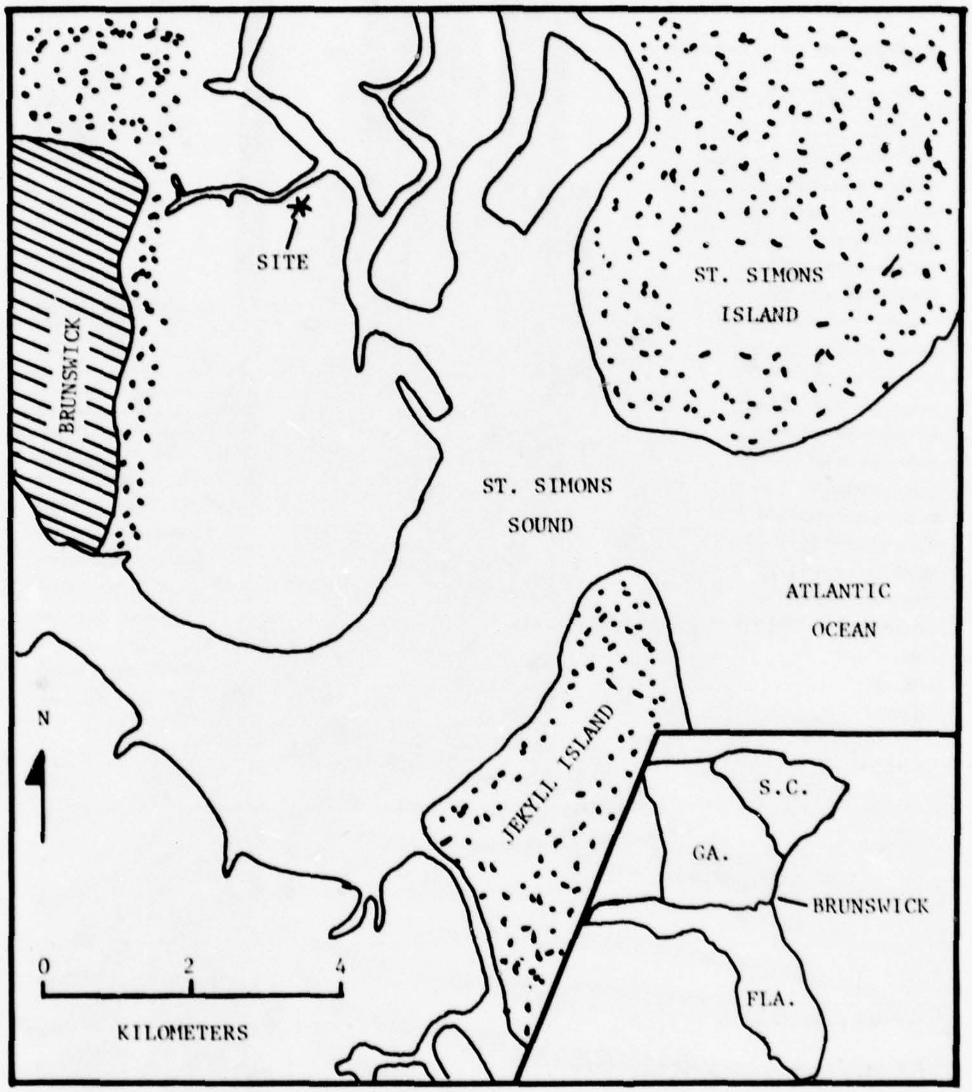


Figure 1. Location of Marsh Smothering Site.

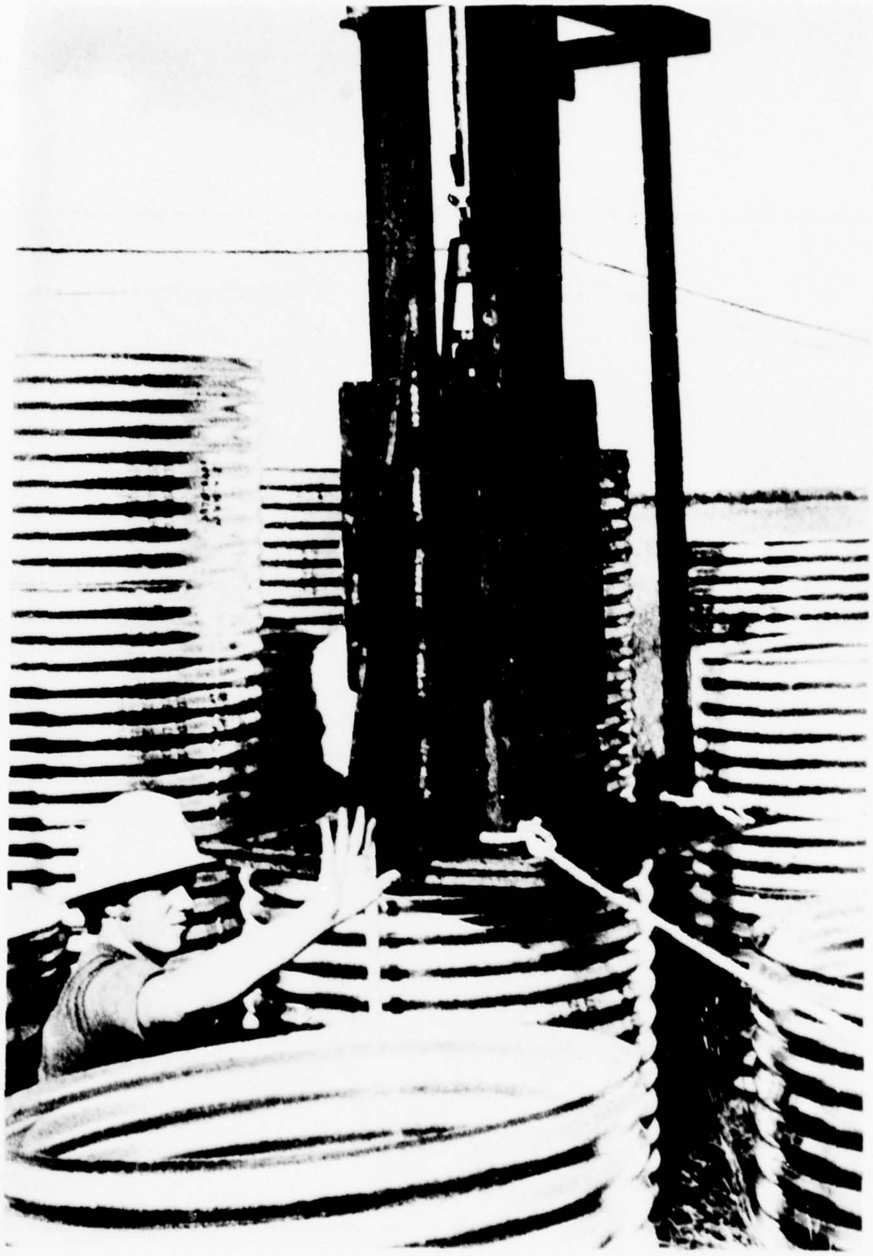


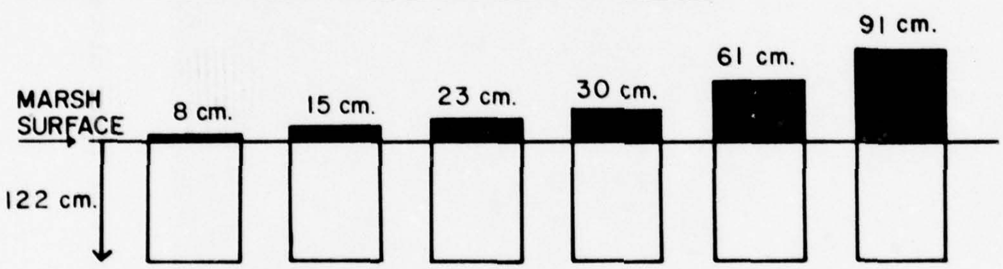
Figure 2. Each enclosure was measured during insertion to ensure proper height above the marsh.

TYPE OF DREDGED MATERIAL

SAND | SAND / CLAY MIXTURE | CLAY

BUTTERMILK SOUND, GA. | DARIEN RIVER, GA. | JEKYLL CREEK, GA.

DEPTH OF DEPOSITED MATERIAL



TIME OF MATERIAL DEPOSITION

FEBRUARY JULY NOVEMBER

Figure 3. Description of treatments and illustration of experimental enclosures after placement in the marsh.

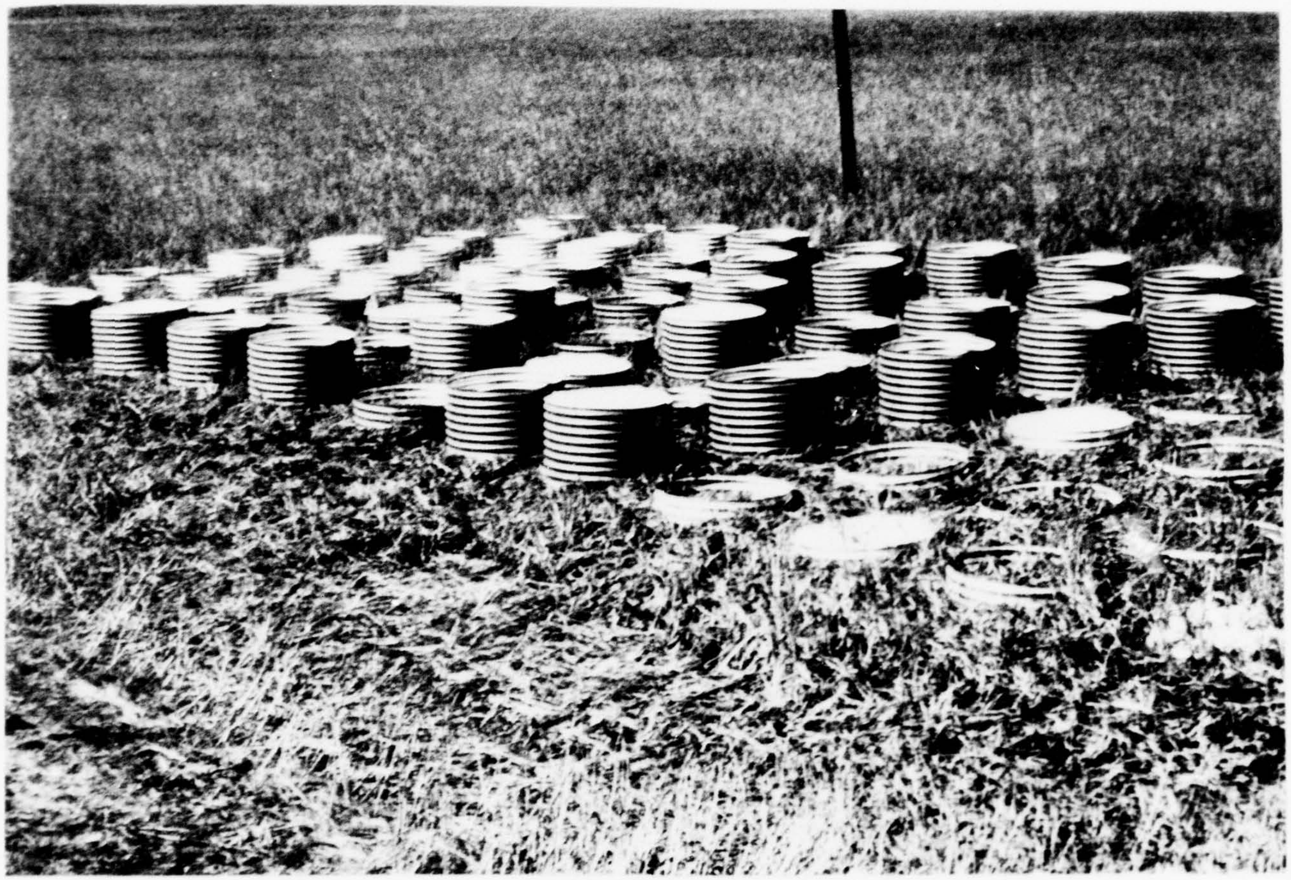


Figure 4. Marsh Smothering site after placement of experimental enclosures.

Figure 5. Sand dredged material was collected with buckets, dumped into drums and shuttled to research vessel with a small boat.

material disposal site was inundated by daily high tides, thus the material had been maintained in a moist, anaerobic state after being dredged from the waterway (Figure 6). The sand and the sand and clay sites were maintained above mean high water. When the research vessel arrived at the dock, the dredged material was hoisted from the vessel and onto a truck (Figure 7) for subsequent transport to the marsh smothering site.

6. The dredged material was dipped from the drums with buckets and dumped into the appropriate enclosure (Figure 8). All enclosures were filled with dredged material to the top of the enclosure. The 8 and 15 cm enclosures after being filled had most of the taller *Spartina alterniflora* culms protruding the surface of the dredged material. The only culms protruding the 23 and 30 cm depths were culms which had been pressed against the sides of the enclosures. This edge effect occurred to varying degrees and was the result of the dredged material being dumped at the center of the enclosure and subsequently folding the culms to the side. The 61 and 91 cm fills completely buried the *Spartina alterniflora* inside the enclosures (Figure 9). During the November filling, many of the *Spartina alterniflora* culms had seedheads, thus in several cases a portion of the seedhead was left protruding the dredged material through 61 cm of fill.

Design

7. The experimental design was established as a 3-way factorial design utilizing six filling depths, three types of dredged material and three filling dates to give a 6 x 3 x 3 factorial arrangement. Each treatment combination was replicated three times, except for the November filling where only two replicates were available. All the enclosures were randomized using a table of random numbers for assignment of treatments.

Figure 6. The clay dredged material disposed site was inundated by daily high tides. Dredged material was loaded on a small boat for transport to research vessel.

Figure 7. Off loading drums filled with dredged material from the research vessel to a truck for transport to Marsh Smothering site.

Figure 8. Manual dumping of clay dredged material into a 23 cm enclosure.

Figure 9. Smothering a 61 cm enclosure with clay dredged material. No culms exceeded the top of the enclosure.

Enclosure Controls

8. Three replicates of each height enclosure were set aside as control areas to monitor any container effect. The control enclosures were sampled monthly in the same manner as the experimental enclosures.

Adjacent Marsh Controls

9. Five randomly selected areas in the *Spartina alterniflora* marsh adjacent to the experimental enclosures were monitored monthly in the same manner as the experimental areas. An 0.656 m^2 circular ring was placed on the marsh for culm, live crab, crab burrow and marsh snails density determinations. These areas served as a control to normal seasonal fluctuations in the measured populations.

3m X 3m Enclosure Controls

10. Two square enclosures measuring 3 m on a side ($9m^2$) were constructed to test changes in measured populations which might be attributable to the smaller 0.656 m^2 experimental enclosures and to ascertain the affect of a larger enclosure (Figure 10). The enclosure consisted of 1.5 m lengths of galvanized corrugated steel roofing driven into the marsh 1.2 m, leaving 30 cm above the surface. Although each section of steel was overlapped 5 to 10 cm, some gaps remained allowing entry to tidal waters and possibly very small fiddler crabs. This was slightly different from the experimental enclosures which allowed tidal water entry at small drain holes at the dredged material level. Fiddler crab movements from the experimental enclosures were restricted to escape or entrance over the top of the enclosure.

11. Monthly sampling of the enclosures entailed the same techniques described for the adjacent marsh controls except only two replicates were performed. Care was exercised in the gathering of information from the 3m x 3m enclosure in order that minimal damage be inflicted upon the resident plant and animal populations.

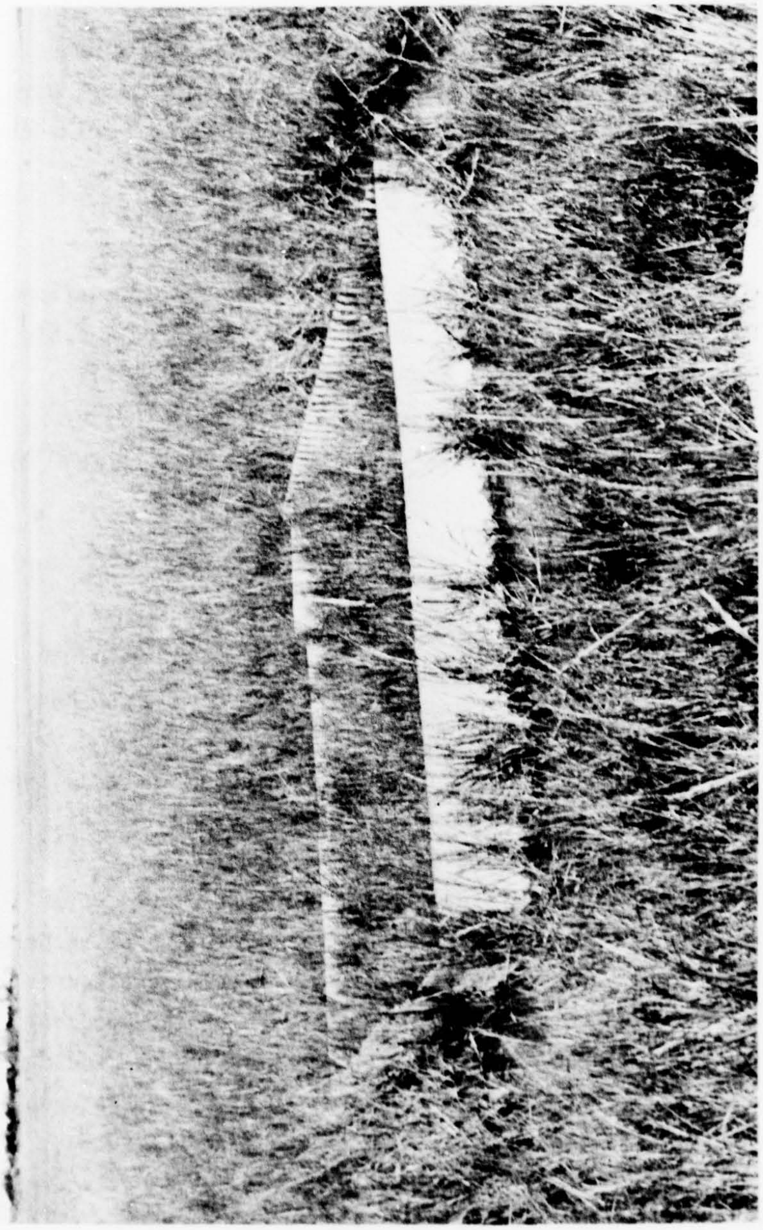


Figure 10. 3m x 3m enclosure area adjacent to Marsh Smothering site.

Culm Density

12. The measurement of culm density was accomplished by counting all live shoots within each 0.656 m^2 enclosure. Any culm having green or purple coloration was considered living. Counting all live culms within an enclosure reduced the random sampling error between successive intervals associated with subsample quadrat measurements. Monthly density counts began immediately after each of the three fillings so as to measure the initial status of each filled enclosure. In many of the shallower filling depths, a number of stems protruded the dredged material surface immediately after filling. Documentation of culm densities surviving the filling operation helped to better estimate the true recovery potential of each enclosure. All culm density counts used in the analysis were converted and expressed as the number/m^2.

13. The treatments tested in the analysis of variance were depth of dredged material, dredged material type, and month of deposition. Culm density was the only regularly monitored response parameter which was a direct measurement of the plant population. Culm density served as the most consistent measure of plant response for all treatments. Normal fluctuations in culm densities of the *Spartina alterniflora* population were monitored via control areas in surrounding marshes.

Live Crabs and Crab Burrows

14. Considering the recovery of a marsh from a perturbation as physically damaging as dredged material deposition, it was necessary to assume cessation of a majority of normal marsh functions. From this viewpoint, monitoring of plant populations as well as associated macroinvertebrate populations was essential in documenting the reestablishment of a viable marsh. Fiddler crabs were found in large numbers in a *Spartina alterniflora* highmarsh (Wolf et al. 1975) similar to the one under study. Therefore, the reestablishment of fiddler and squareback crab populations should accompany the marsh recovery.

15. Estimation of crab populations was accomplished in two ways:

1) density of observed live crabs and 2) density of crab burrows contained in each enclosure. Before filling, *Uca pugnax* was the major inhabitant of the marsh inside the enclosures. After filling, the change in substrate type attracted *Uca pugilator* and *Sesarma reticulatum* to the filled enclosures. The density of live crabs represented the total observed of all species. Density of live crabs was dependent upon weather conditions and the time spent by each field team in estimating the relative number. Since live crab density was such a variable measure, its model was used only to substantiate the existance and species of crab populations described by the crab burrow densities. Crab burrow densities represented crab activity, however, no actual correlation between population numbers and burrows present was ever performed. The comparison of adjacent marsh burrow densities and enclosure burrow densities served as a relative index of recovery.

Marsh Snails

16. Along with the crab populations, the marsh periwinkle (*Littorina irrorata*) and the coffee bean snail (*Melampus bidentatus*) were inhabitants of adjacent *Spartina alterniflora* high marshes. Unlike the crab populations, the snail populations are dependent upon the salt marsh vegetation and associated epiphytes for survival. Therefore, the return of the snail populations in the experimental enclosures was expected to be slower than the crab populations. The two species of snails were counted within each enclosure to determine density expressed as snails/m^2. Care was exercised while counting not to include abandoned shells lying on the dredged material surface in the density count.

Standing Crop Biomass

17. Culm density was a parameter having some variation and not always being proportional to the biomass present. There was need of a technique by which biomass could be estimated without destroying the plants within the 0.656 m^2 enclosures. By deriving biomass, a more

equitable comparison of success between experimental treatments could be made.

18. The linear relationship of *Spartina alterniflora* culm height to biomass (linear regression) for *Spartina alterniflora* was tested in Connecticut marshes by Nixon and Oviatt (1973), in North Carolina by Williams and Murdock (1969), and in Florida and on the Gulf coast by Turner and Gosselink (1975). All studies described significant relationships of height with biomass and Turner and Gosselink pointed out changes in the regression coefficient with latitude, suggesting localized equations would provide the best fit. Therefore, in developing a predictive regression equation, culms were collected at several times during the growing season from *Spartina alterniflora* marshes surrounding the study area (Reimold and Hardisky, in preparation). Each culm was measured (height in cm) dried at 100°C to a constant weight and weighed to the nearest 0.001 g. The grams dry weight biomass and the height (cm) were used to derive a linear regression equation. Predictive regression equations derived for *Spartina alterniflora* high-marsh at Marsh Smothering site were:

LIVE CULMS $\hat{y} = 0.076*(\text{Height})$ Equation (1)

Height is expressed in cm, r^2 equaled 0.86 significant at the 0.0001 level, and there were 600 observations.

DEAD CULMS $\hat{y} = 0.054*(\text{Height})-(0.988)$ Equation (2)

In Equation 2, Height is expressed in cm, r^2 equaled 0.64 significant at the 0.0001 level, and there were 604 observations.

19. In April 1977 0.05 m^2 circular quadrats were positioned in each of the experimental enclosures and all control areas provided some *Spartina alterniflora* was present. Placement of the quadrats was random in enclosures containing substantial vegetation, however, in enclosures of limited recovery the quadrat was positioned to contain some of the living culms. The quadrats were staked and remained in each enclosure for the duration of the experiment. The height of each live or dead culm was measured from the soil surface to the tip of the tallest leaf or seedhead. Subsequent summation of live culm heights and dead culm heights and substitution into the appropriate equations yielded the

grams dry weight (gdw) live and dead standing crop biomass. The estimate of biomass for experimental enclosures was compared to enclosure controls (3 replicates of each height), adjacent marsh (5 replicates), and 3m x 3m enclosures (4 replicates). Biomass was estimated by the same procedure in November 1977 utilizing the same quadrats.

20. Biomass estimates of the adjacent *Spartina alterniflora* highmarsh utilizing destructive techniques were performed monthly utilizing 0.1 m^2 circular quadrats (Reimold and Linthurst, 1977). The determination of standing crop biomass by traditional harvest techniques compared to non-destructive estimates of biomass indicated the relative accuracy of the non-destructive methods.

Soil Chemistry

21. Soil samples were collected using a 4.4 cm (I.D.) section of PVC irrigation pipe as a coring device. The PVC pipe was pushed into the substrate, a rubber stopper placed over the top opening and the pipe and core sample removed. The soil was extracted from the pipe onto a sheet of aluminum foil. The core sample was wrapped, sealed and transported on ice to the laboratory. The substrate was homogenized and composited, if necessary, before subsamples for nutrient analysis were taken. All mineral analyses were conducted by the University of Georgia Soil Testing Laboratory.

22. Analyses of potassium, calcium and magnesium were according to Issac and Jones (1971) for determination on an Auto Analyzer System. Other trace mineral methodologies were: boron, Wolf (1971); sulphur, Jones and Issac (1972); extractable zinc, manganese, and iron, Nelson et al. (1953), Perkins (1970); copper, cobalt, and arsenic, Issac and Kerber, (1971). Organic matter determination were performed according to Jackson (1958), pH determinations were performed according to Peech (1965), and Eh determination according to Pearsall and Mortimer (1939). Extractable phosphorus was determined using an oxalate extraction procedure (Saunders 1965) with the following modification: shake sediment with oxalate solution (0.1M oxalic acid + 0.2M ammonium oxalate pH

3.25) in a solid to extractant ratio of 1:20 (oven dry basis) for two hours and centrifuge. Filter the supernatant solution through 0.45 micron filter paper and analyze (Khalid and Patrick, personnal comm.). Analyses of extractable and total phosphorus were performed according to Technicon (#94-70W, 1973) and Technicon (#376-75W, 1975) respectively. Nitrate and nitrite (Armstrong et al. 1967) ammonia (FWPCA, 1969), total dissolved and total nitrogen (Van Slyke and Hiller 1933), were analyzed using an Auto Analyzer II. The cation exchange capacity (CEC) was determined using a slightly modified version of Toth and Ott (1970). Isopropyl alcohol (99 percent) was substituted for ethyl alcohol in the washing step for the reasons outlined in Chapman (1965). Determination of the index, ammonia, was accomplished as previously described using the Auto Analyzer II system.

Elevation

23. Tidal data for the experimental area was from a tide gauge stationed at the State Docks in Brunswick, Georgia, some 4 km from the study area. The elevation of each enclosure before and after filling was determined from a U.S. Geodetic Benchmark at the Back River bridge, approximately 0.5 from the experimental area. The elevation was taken as the mean of 3 random points on the surface of the dredged material. Daily tidal data was used to estimate the frequency of inundation of the experimental enclosures (Table 1). Enclosure elevations were determined to be the height of the consolidation, therefore, many of the 61 and 91 cm enclosures were theoretically inundated. The enclosure walls contained drain holes at the dredged material surface which allowed inundation of these areas. The consolidation of each dredged material after 10 days (Table 2) indicated the high degree of shrinkage of the dredged material as compared to the enclosure walls. This consolidation accounted for the inundations of the 61 and 91 cm enclosures. The small drain holes restricted the inundation of tidal waters and limited the degree of actual inundation.

24. All data was punched on IBM punch cards and stored on magnetic tape at the University of Georgia. Statistical analyses and graphical

TABLE 1

FREQUENCY OF TIDAL INUNDATION IN NUMBER OF EVENTS PER MONTH FOR MARSH SMOTHERING EXPERIMENTAL ENCLOSURES

	DATE	8 cm.	15 cm.	23 cm.	30 cm.	61 cm.	91 cm.
	JANUARY	19	16	8	6	0	0
	FEBRUARY	14	12	11	9	0	0
	MARCH	19	18	12	10	0	0
	APRIL	26	22	17	14	3	0
1	MAY	32	29	22	21	5	0
9	JUNE	38	34	31	25	9	0
7	JULY	12	9	7	7	0	0
6	AUGUST	37	37	28	27	1	0
	SEPTEMBER	38	37	27	25	2	0
	OCTOBER	40	40	30	24	0	0
	NOVEMBER	26	23	17	15	2	0
	DECEMBER	7	6	5	3	0	0
	JANUARY	20	16	10	8	0	0
	FEBRUARY	19	13	7	6	0	0
1	MARCH	29	25	20	15	0	0
9	APRIL	31	22	17	17	0	0
7	MAY	45	41	36	31	7	1
7	JUNE	40	34	33	31	8	3
	JULY	36	32	26	24	6	1
	NOVEMBER	49	45	35	33	6	2

TABLE 2

Average Vertical Consolidation of Dredged Material Ten Days After Placement in Marsh Smothering Enclosures

Dredged Material:	SAND		SAND AND CLAY		CLAY	
Original Depth of Dredged Material in cm	Average Vertical Shrinkage in cm	% Consolidation	Average Vertical Shrinkage in cm	% Consolidation	Average Vertical Shrinkage in cm	% Consolidation
8	3.6	47.4	2.9	38.2	2.0	26.3
15	4.2	27.6	1.6	10.5	4.1	27.0
23	4.7	20.5	3.8	16.6	6.4	27.9
30	5.2	17.0	4.3	14.1	7.1	23.3
61	7.0	11.5	4.3	7.0	11.6	19.0
91	6.1	6.7	3.8	4.2	13.6	14.9

representations were according to the established procedures of Barr et al. (1976) using an IBM 370 computer.

PART III: PLANT AND MACROINVERTEBRATE RESPONSE

25. Measurements of the dependent variables, culm density, live crab and crab burrow density and snail density, were conducted monthly within each enclosure. Densities included in the analysis of variance (GLM) were from December 1976 through November 1977. The three filling periods (February, July, November) had been completed by December, thus providing a more equitable comparison of treatments for the model. Problems associated with response time were evident throughout the statistical analysis. Significant differences among treatment means were expressed at the 0.05 level using Duncans' Multiple Range test. The complete analysis of variance and means for each treatment combination for all dependent variables are found in Appendix A.

Culm Density

26. Monthly changes in culm densities inside the experimental enclosures and control areas are depicted in Figures 11 through 21. The monthly culm densities for experimental enclosures represented in the figures were a mean of the 3 replicates of each treatment combination. The November smothering period was represented by means of 2 replicates. The control enclosure mean densities were means of 3 replicates and the adjacent marsh control were means of 5 replicates. Occasionally very large increases or decreases in culm density within a treatment combination was the result of an inexperienced sampler or error in recording culm density. The large breaks in the histograms were obvious and actual densities were best represented by the preceeding and following months.

February 1976 Smothering

27. The February filling showed no recovery of *Spartina alterniflora* in 61 and 91 cm enclosures for the two sandy dredged materials and only *Spartina alterniflora* seedlings in 61 and 91 cm enclosures filled with clay dredged material (Figures 11 through 13). Culm density immediately after filling for each enclosure height was greatest for the sand dredged material, next was the sand and clay material and about half the density

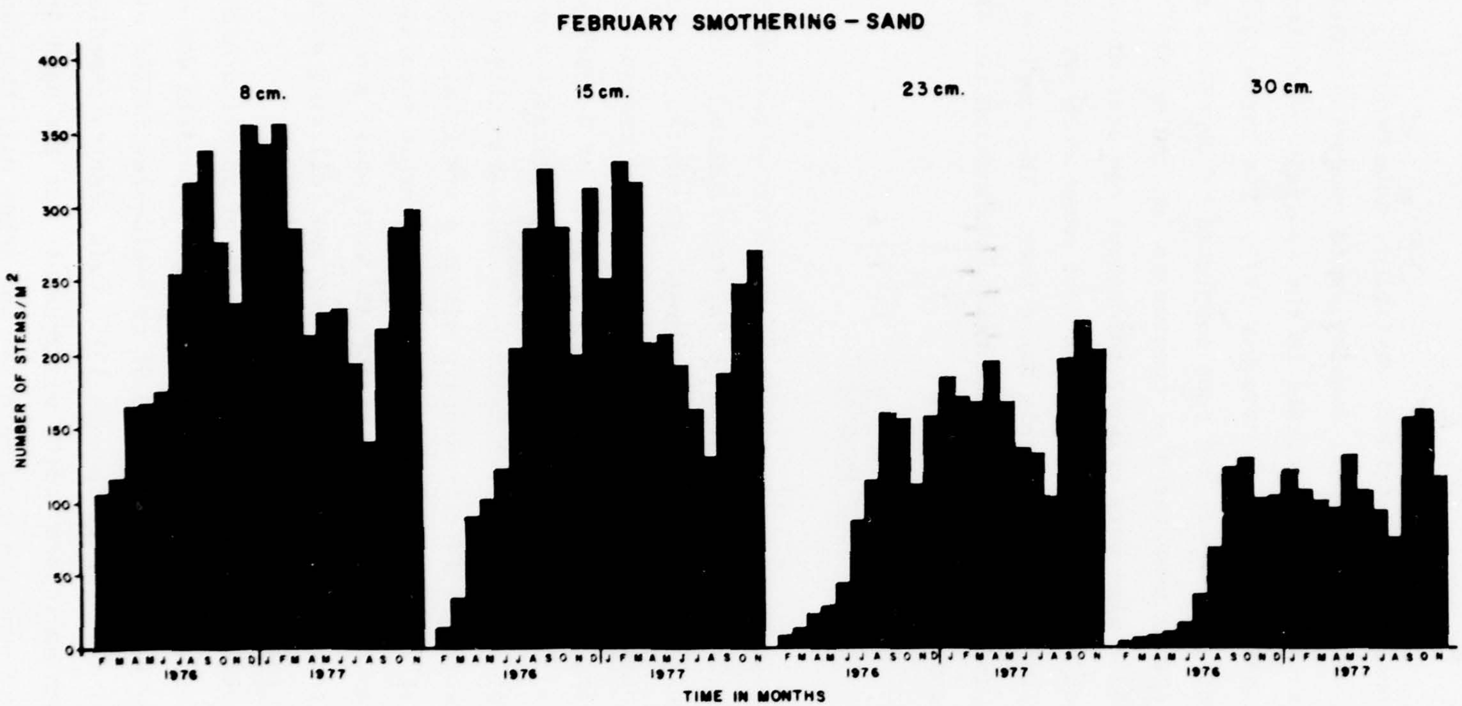


Figure 11. *S. alterniflora* culm density in experimental enclosures smothered with sand dredged material in February 1976.

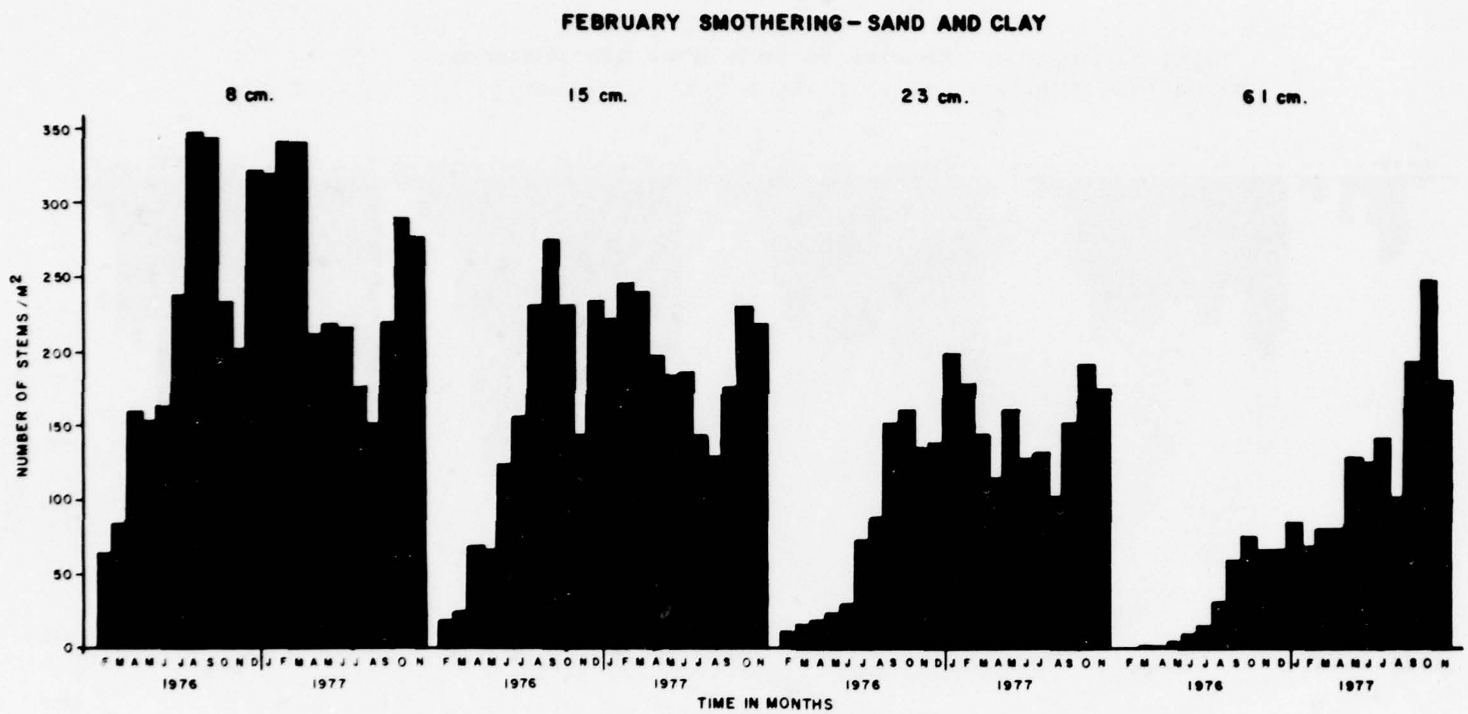


Figure 12. *S. alterniflora* culm density in experimental enclosures smothered with sand and clay dredged material in February 1976.

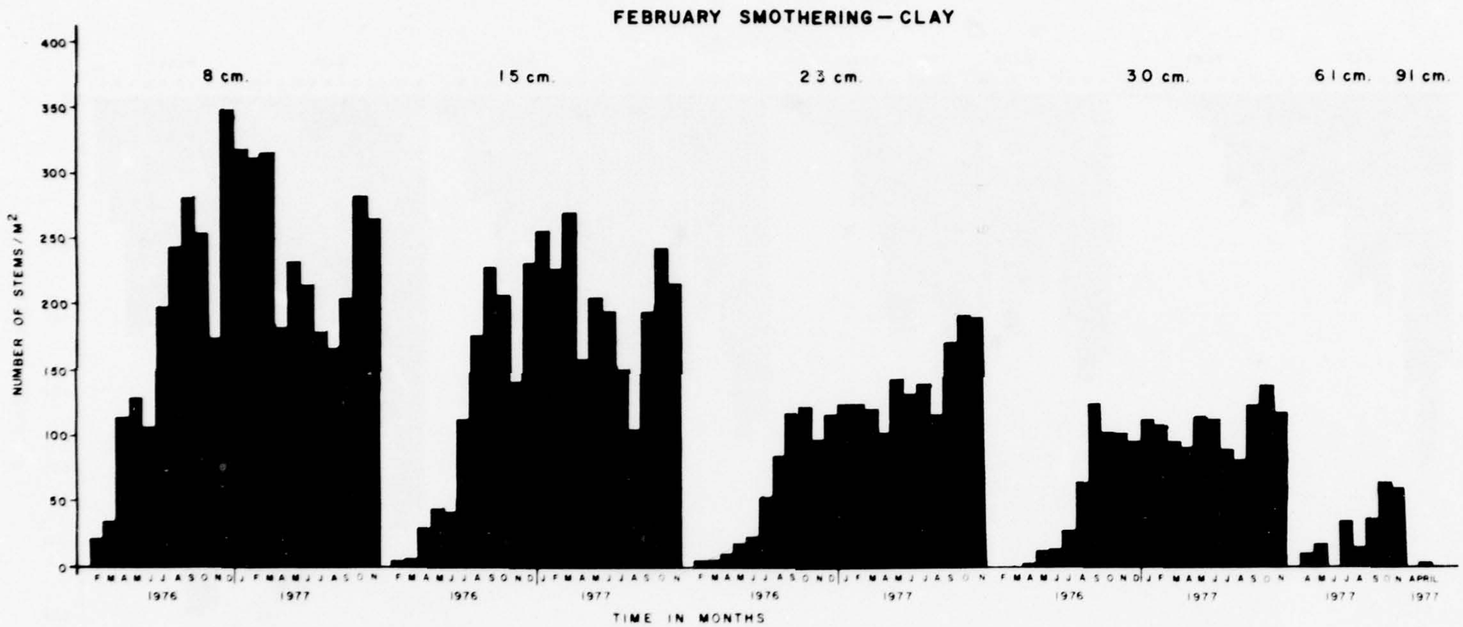


Figure 13. *S. alterniflora* culm density in experimental enclosures smothered with clay dredged material in February 1976.

of the sandy materials was the clay dredged material. The physical nature of the clay dredged material was more damaging to the underlying vegetation than were the sandy dredged materials. As the depth of dredged material increased, the initial culm density decreased as well as the time required to initiate recruitment.

28. After the February smothering operation, each of the dredged material types showed large density increases two months after filling (April) and again 5 to 7 months after filling (July - September) in the 8 cm enclosures. The 15 cm enclosures also manifested two peak recruitment periods, however, the April increase was much smaller and the July through September increase failed to attain culm density levels of the 8 cm enclosures for sand and clay and clay dredged material. The 23 and 30 cm enclosures experienced only small increases in culm density until July through September when rapid recruitment occurred. The initial response time for the 23 and 30 cm enclosures was 5 months instead of 2 months exhibited by the shallower fills. Culm densities were generally lower for the clay dredged material and the 30 cm enclosures had lower densities than the 23 cm enclosures. This suggested that depth of dredged material would be a primary determinator of marsh recovery. Figures 14 through 16 depict culm density recovery in each dredged material type four months after the February smothering operation.

29. The culm densities attained by the February filled 8 and 15 cm enclosures by the end of 1976 were in most cases the maximum culm density of the enclosures for the 2 year experimental period. Figure 17 depicts *Spartina alterniflora* recovery from the February filling of sand dredged material in November 1976. The 23 and 30 cm enclosures continued to show improvement over the entire experimental period. Figure 18 illustrated the lack of recovery of *Spartina alterniflora* in clay dredged material for a 61 cm enclosure filled in February 1976. After the smothering operation July and August produced large increases in culm densities in the filled enclosures, but during 1977 July and August were not peak recruitment periods for experimental or control areas. This indicated the increases were the result of the vegetation responding to the perturbation and not to seasonal population fluctuations.

Figure 14. *Spartina alterniflora* recovery four months after smothering with sand and dredged material.

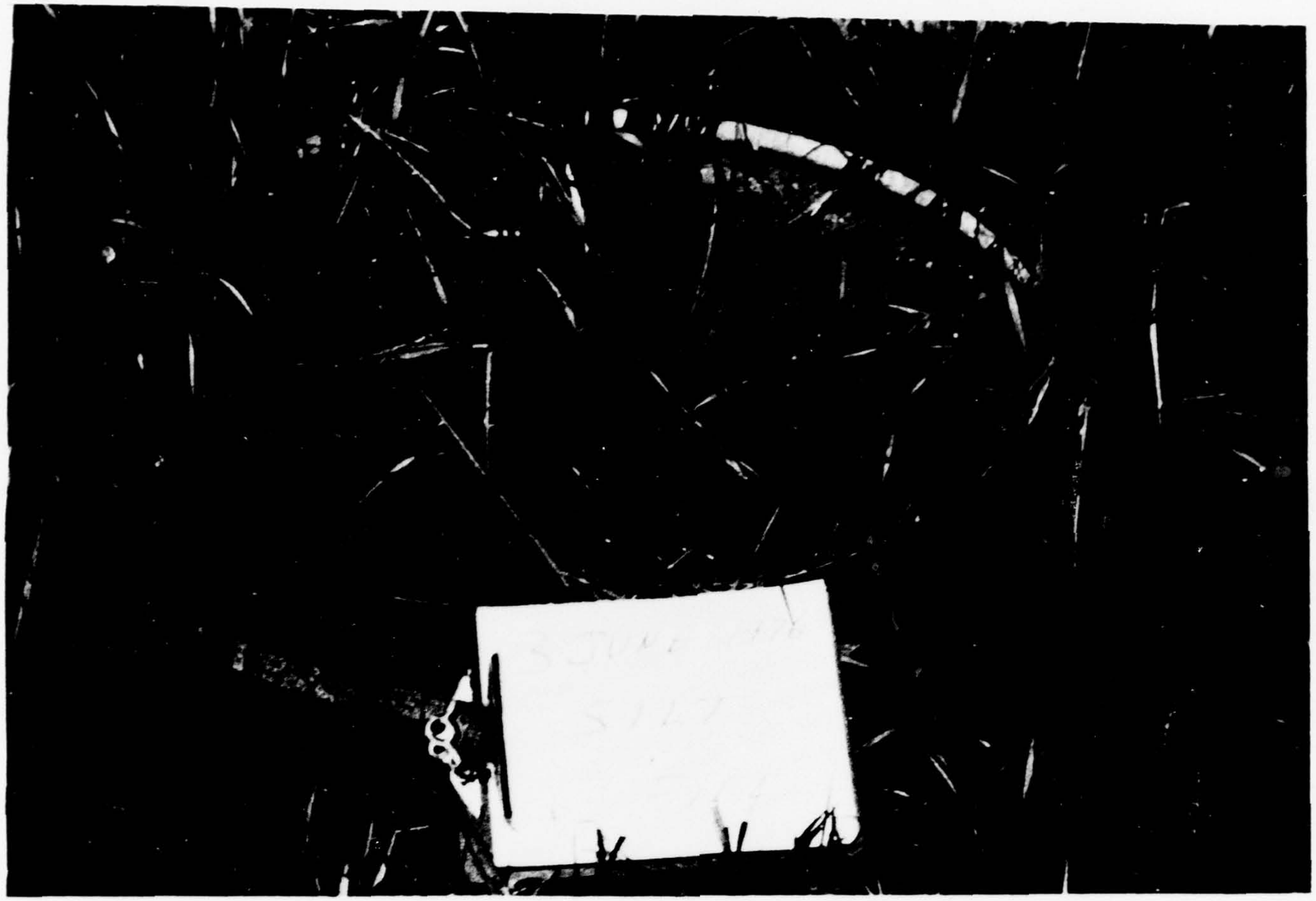


Figure 15. *Spartina alterniflora* recovery four months after smothering with sand and clay dredged material.

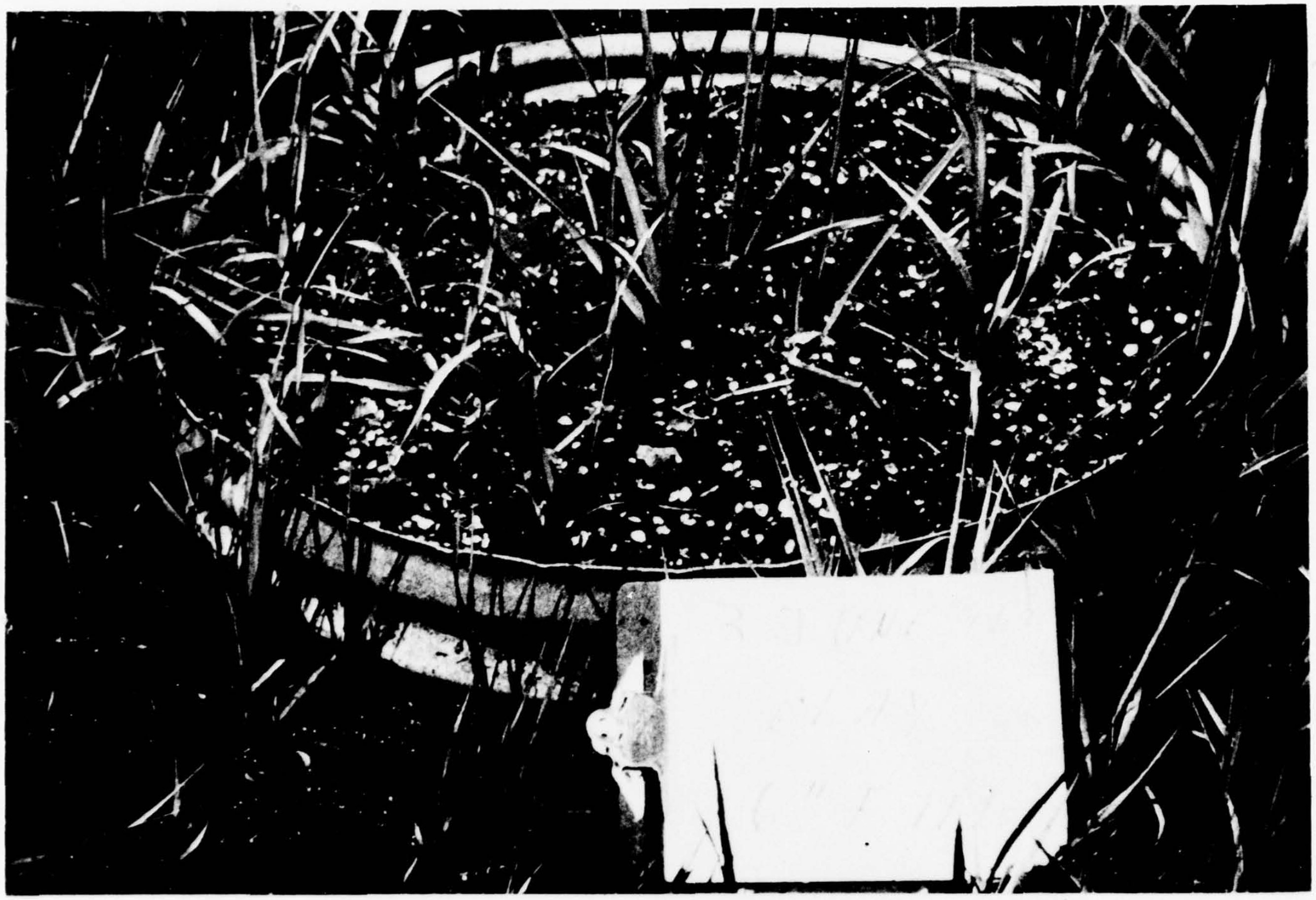


Figure 16. *Spartina alterniflora* recovery four months after smothering with clay dredged material.

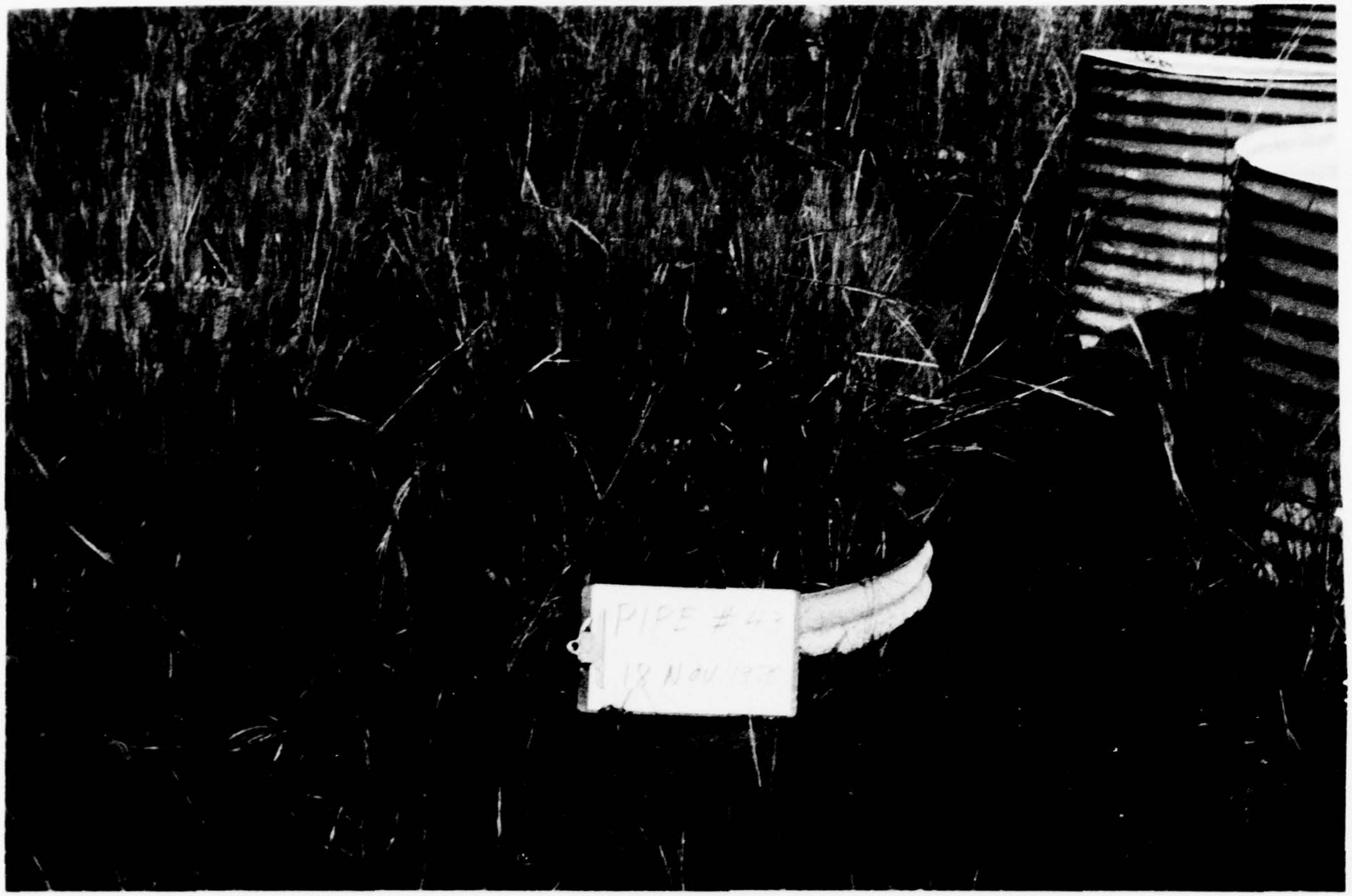


Figure 17. *Spartina alterniflora* recovery as of November 1976 in a 15 cm enclosure smothered in February 1976.

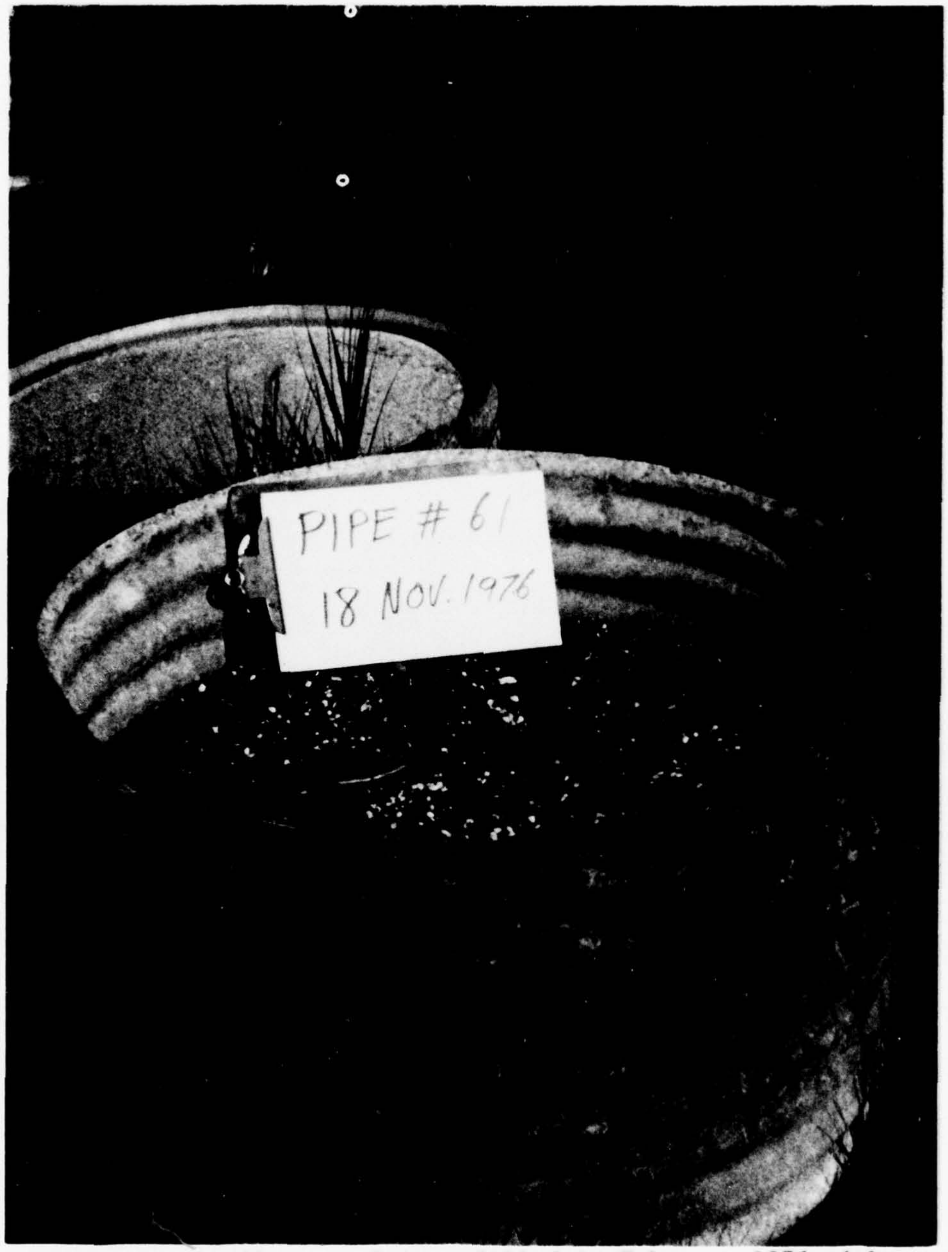


Figure 18. A 61 cm enclosure filled in February 1976 with clay dredged material showed no *Spartina alterniflora* recovery as of November 1976.

July 1976 Smothering

30. The July smothering operation produced no recovery in 61 and 91 cm enclosures for the two sandy dredged materials and limited seedling survival in the clay dredged material (Figures 19 through 21). This midseason filling operation found a higher proportion of tall *Spartina alterniflora* culms, consequently culm densities immediately after filling were higher than had been for the February filling. This was especially true for 15, 23 and 30 cm enclosures. The clay dredged material had lowest culm densities, the sand and clay was next and the sand dredged material showed the highest culm densities immediately after filling. Initial culm densities were successively less as the depths of the dredged material increased.

31. Recovery began almost immediately after the July smothering operation. The 8, 15 and 23 cm enclosures experienced rapid recruitment during August, September and October. Increases were as little as twice the initial density in sandy dredged material to as much as triple the initial density for the enclosures filled with clay dredged material. The magnitude of the density increases was slightly attenuated with increasing dredged material depth. The 30 cm enclosures had markedly lower densities and failed to manifest the rapid recruitment phase exhibited by the shallower enclosures. *Spartina alterniflora* appeared in the 61 and 91 cm enclosures during the second growing season as natural seedlings but only a small clump in a 91 cm enclosure filled with clay dredged material managed to survive to the completion of the experiment.

32. The rapid culm density increase during August through October for the 8 cm enclosures produced the greatest culm densities for the sand and the clay dredged material. The sand and clay dredged material produced maximum densities in the spring of 1977. The 15 cm enclosures filled with sand and sand and clay dredged material yielded maximum densities in October 1976. The 23 and 30 cm enclosures demonstrated a more gradual density increase with time. Many of the 23 and 30 cm enclosures had attained maximum density at the end of the experimental period in the fall of 1977. By the end of the experiment the culm

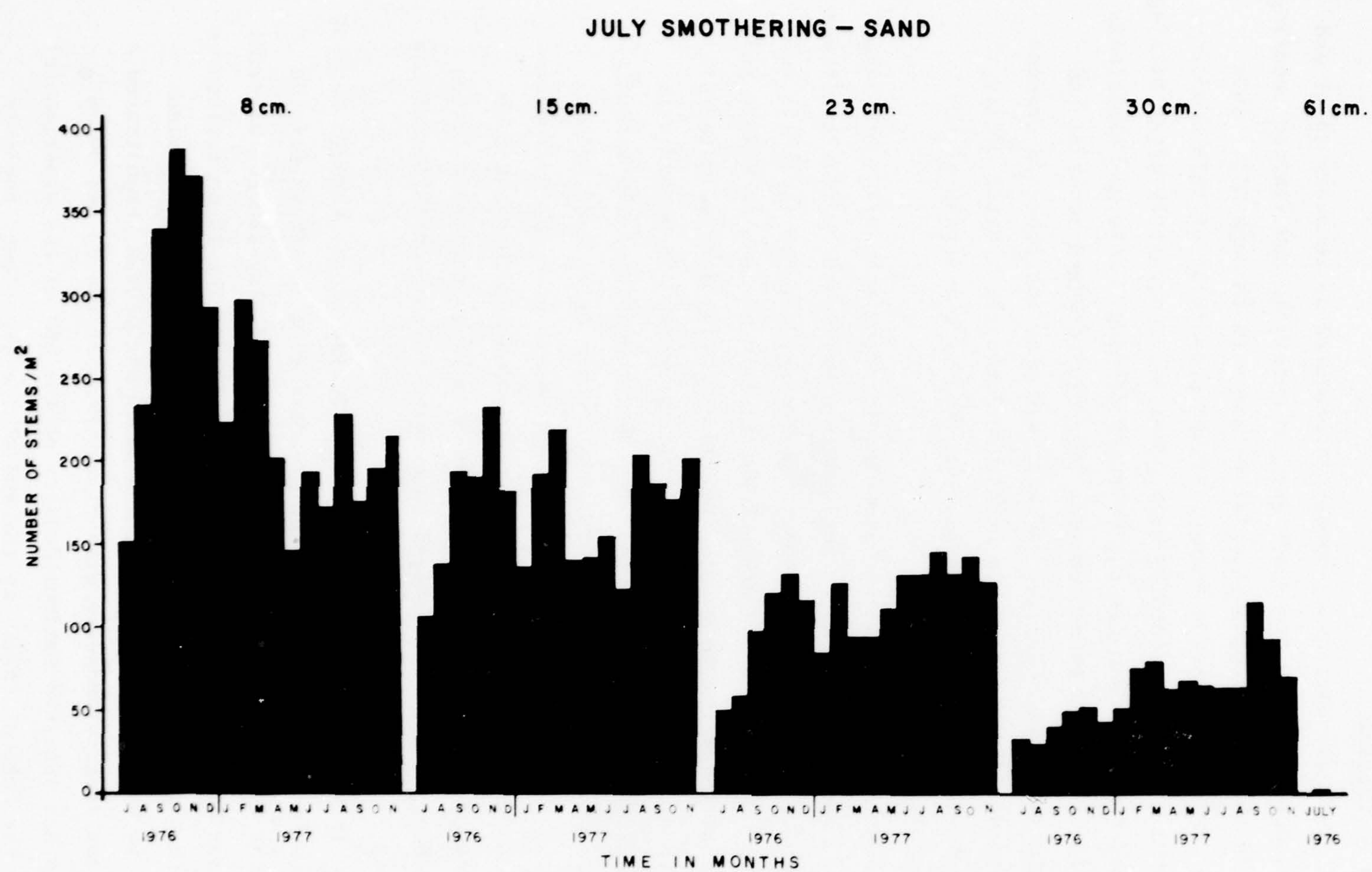


Figure 19. *S. alterniflora* culm density in experimental enclosures smothered with sand dredged material in July 1976.

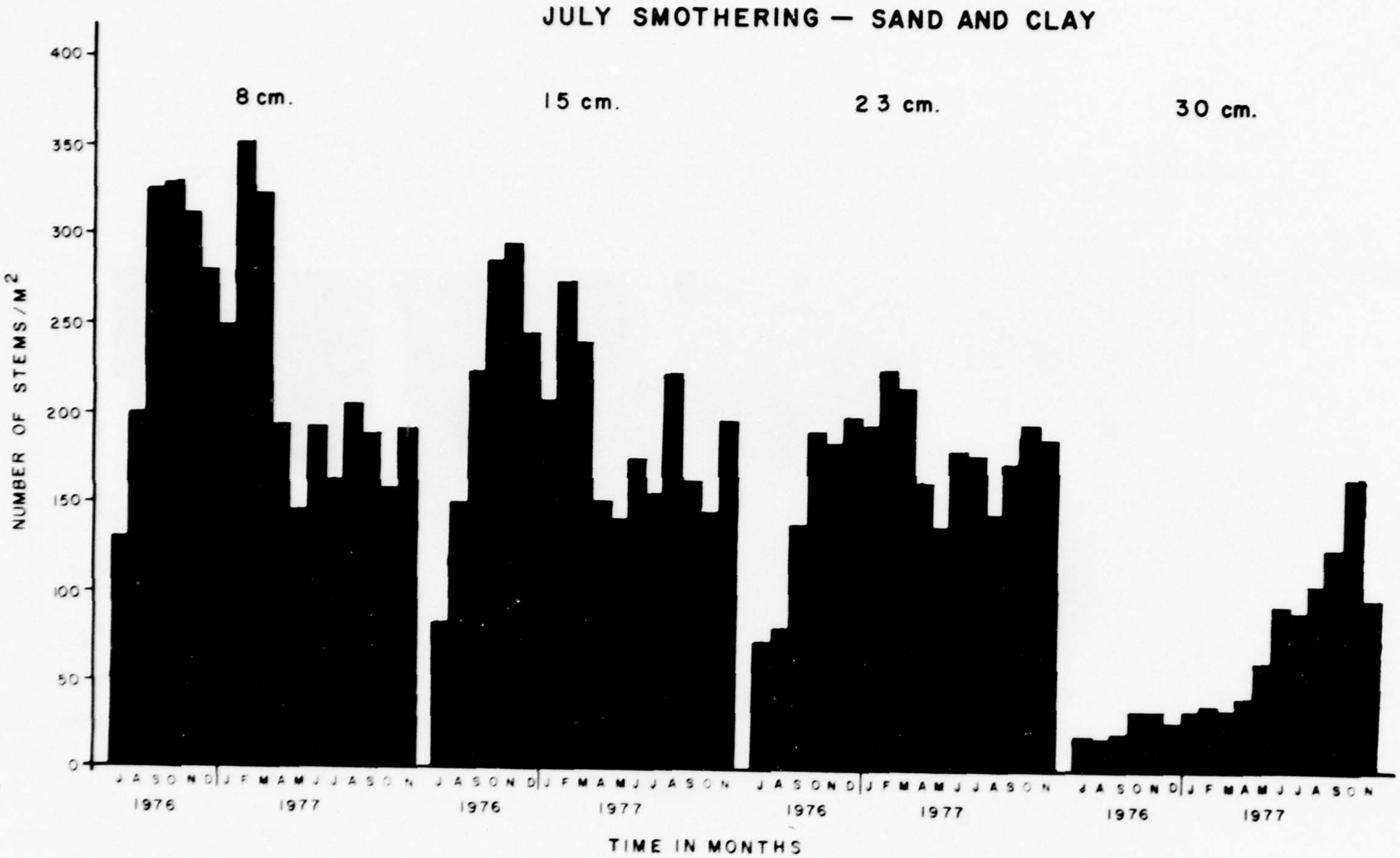


Figure 20. *S. alterniflora* culm density in experimental enclosures smothered with sand and clay dredged material in July 1976.

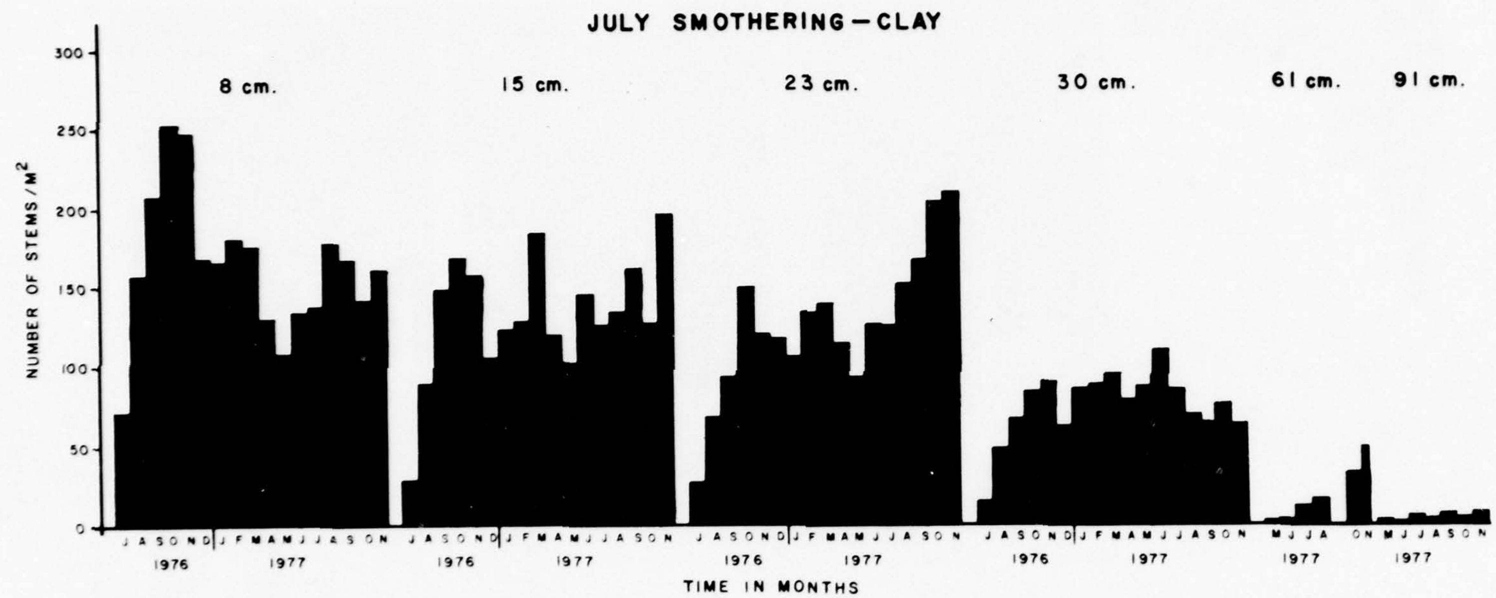


Figure 21 . *S. alterniflora* culm density in experimental enclosures smothered with clay dredged material in July 1976.

densities of the 8, 15 and 23 cm enclosures were nearly identical for each dredged material type. The 30 cm enclosures had somewhat lower culm densities,but had attained comparable density levels in each of the dredged material types. Overall culm density levels for the July smothering operation were less than the culm densities produced by the February smothering operation.

November 1976 Smothering

33. The enclosures smothered in November 1976 for each dredged material type are depicted in Figures 22 through 24. No recovery was noted for the 91 cm enclosures filled with sand and sand and clay dredged materials. By November many of the *Spartina alterniflora* culms inside the unfilled enclosures had attained maximum height and many produced seedheads. The greater proportion of tall culms yielded the high culm densities in the 8 through 30 cm enclosures immediately after smothering. The 8 cm enclosures contained over 150 culms/m^2 for each dredged material type immediately after smothering. The initial density was higher than either the February or the July filling dates. Density increases were relatively small thereafter with the largest increases occurring the following spring (February through April 1977). The 15 and 23 enclosures followed much the same pattern set by the 8 cm enclosures. The initial densities were somewhat lower for the 15 and 23 cm enclosures, however, by the spring of 1977 culm densities were essentially identical. The 30 cm enclosures experienced a sizable increase in culm densities during the spring of 1977, but regained initial density levels during the summer of 1977. Culm densities in the 61 and 91 cm enclosures were the result of tall *Spartina alterniflora* culms, usually with seedheads, extending above the filled enclosures. The culm density increases in the 61 cm enclosures during the spring and summer of 1977 were the result of seedling survival on the surface of the dredged material. Therefore, the response measured by culm density was not a true indicator of recovery from a smothering operation.

34. The 8, 15, and 23 cm enclosures attained similar culm densities by the end of the experimental period for each of the dredged material types. The 30 cm enclosures filled with sand and sand and clay

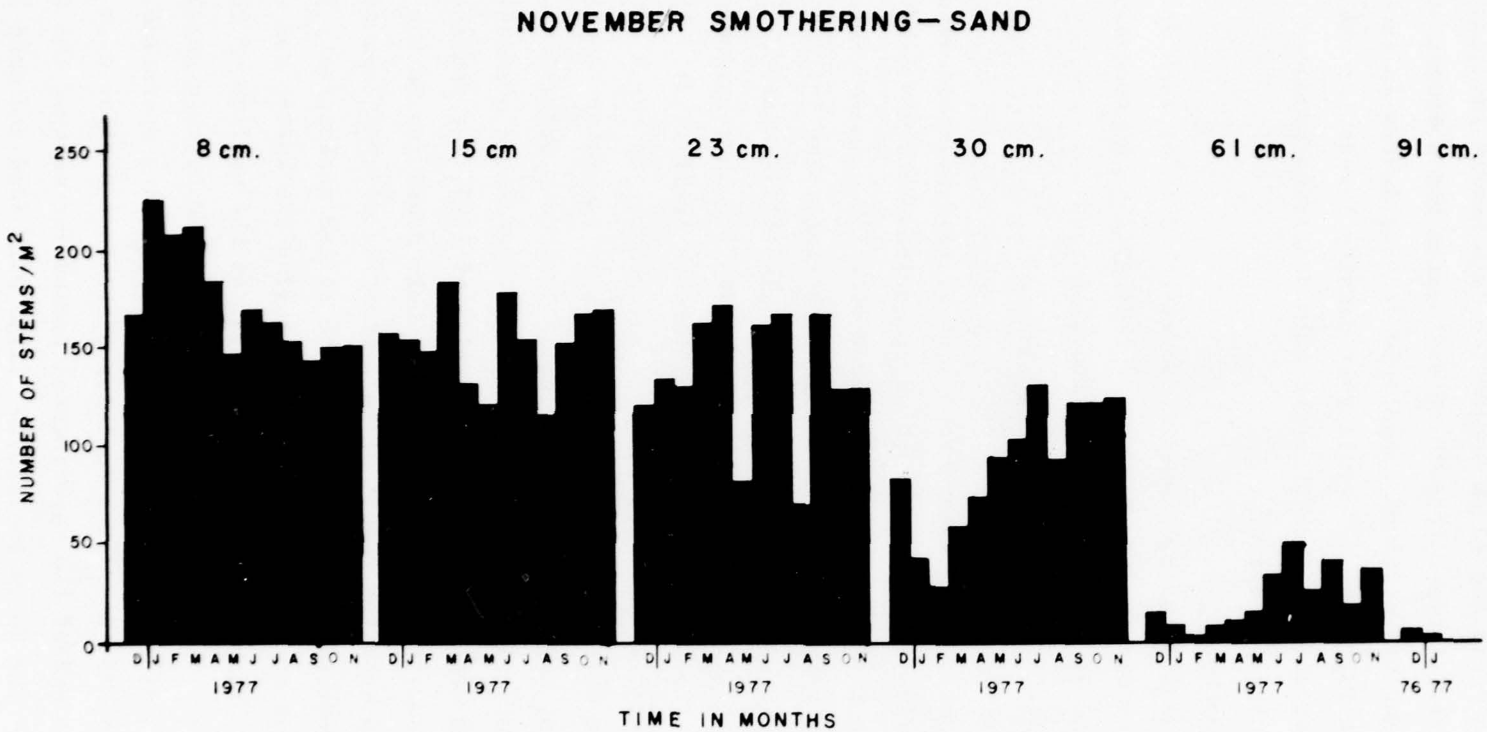


Figure 22. *S. alterniflora* culm density in experimental enclosures smothered with sand dredged material in November 1976.

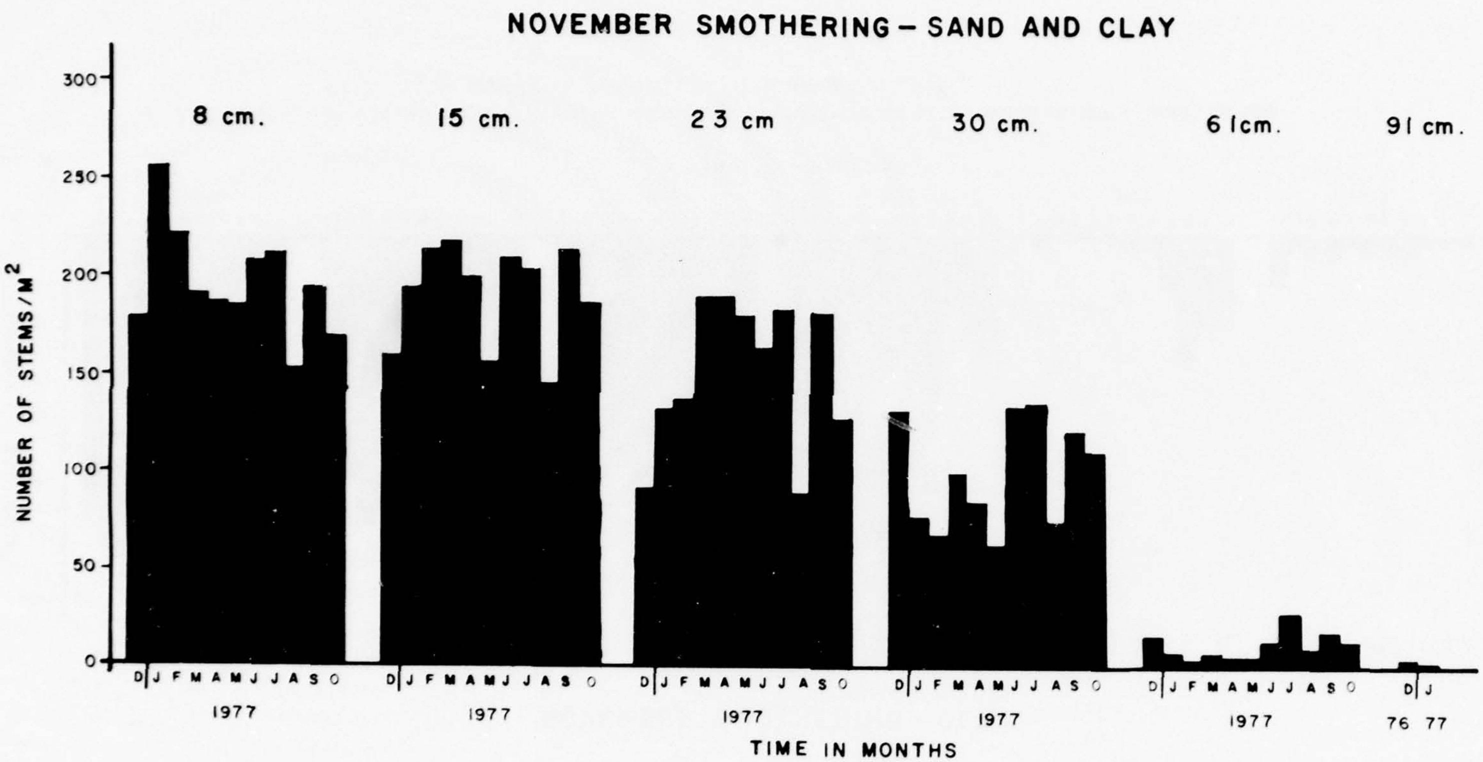


Figure 23. *S. alterniflora* culm density in experimental enclosures smothered with sand and clay dredged material in November 1976.

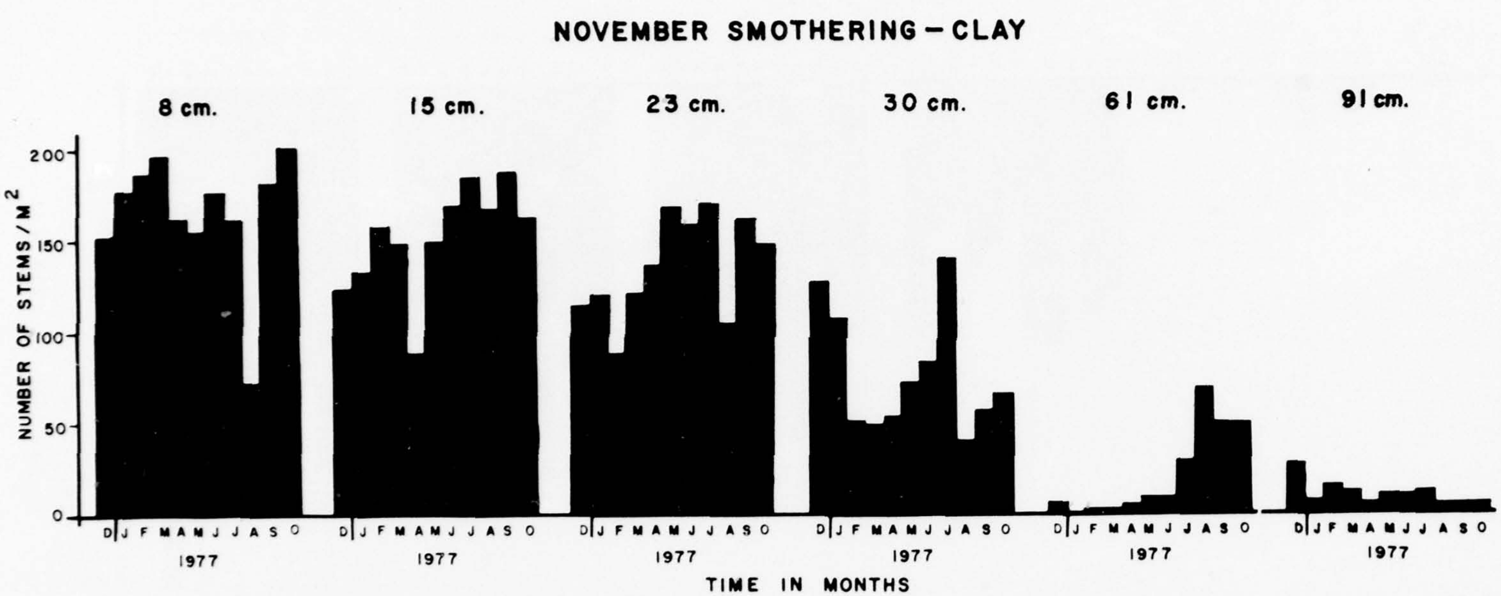


Figure 24. *S. alterniflora* culm density in experimental enclosures smothered with clay dredged material in November 1976.

dredged material yielded similar culm densities which were slightly less than the 23 cm enclosures. The 30 cm enclosures filled with clay dredged material exhibited significantly lower culm densities than the other 30 cm enclosures. Overall the sand and clay dredged material produced the highest culm densities for the November smothering. The culm densities produced in response to the November filling were similar to the July filling culm densities. The February filling yielded the highest culm densities of all filling months, however, by the end of the experimental period only small density differences separated the filling months for each dredged material and enclosure height.

Control Areas

35. Figures 25 and 26 depict the culm densities of the control enclosures and of the adjacent *Spartina alterniflora* marsh. The 8 through 61 cm control enclosures maintained similar culm densities over the experimental period. The 91 cm enclosures revealed a marked reduction in culm density. The culm densities of all enclosure heights decreased with time. The year after insertion of the enclosures, culm densities increased rapidly for all heights, but the second year yielded attenuated densities from the previous year. Restriction of tidal inundation, ground water movement or incident sunlight may have contributed to the initial density peak and subsequent density reduction. The adjacent marsh exhibited a similar culm density pattern, however, the densities were a mean of five random quadrats and did not measure the same areas each month as did the control enclosures. Initially the control enclosures maintained higher culm densities than the adjacent marsh and near the end of the experimental period the enclosure controls yielded lower culm densities than the adjacent marsh.

Models

36. The significance of the experimental treatments (height = enclosure height, soil = dredged material type, and month = filling date) as determined by culm density are found in Table 3. Culm density showed significant mean differences for all treatments and treatment combinations.

37. The treatment of enclosure height (depth of dredged material placed over the marsh) was significant at the 99.99 percent confidence

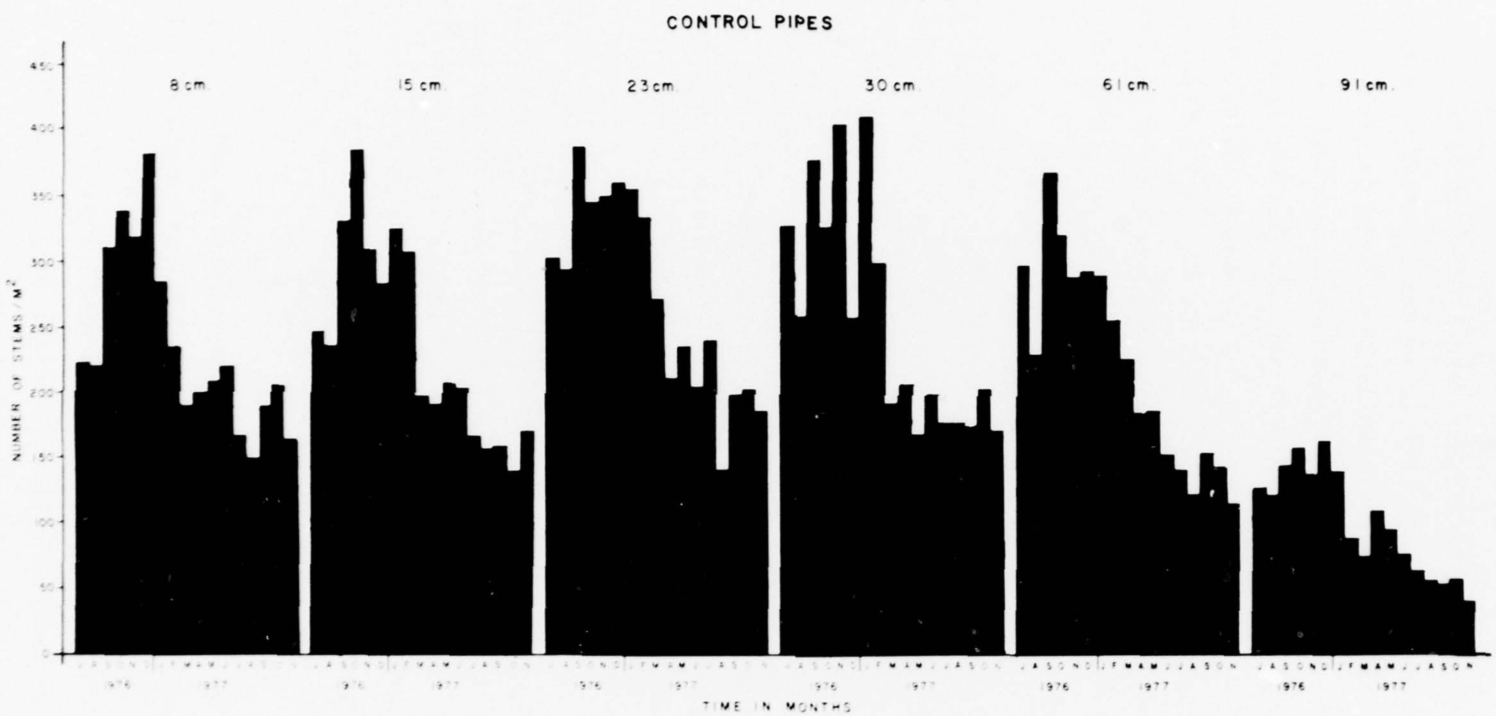


Figure 25 . *S. alterniflora* culm density in control enclosures.

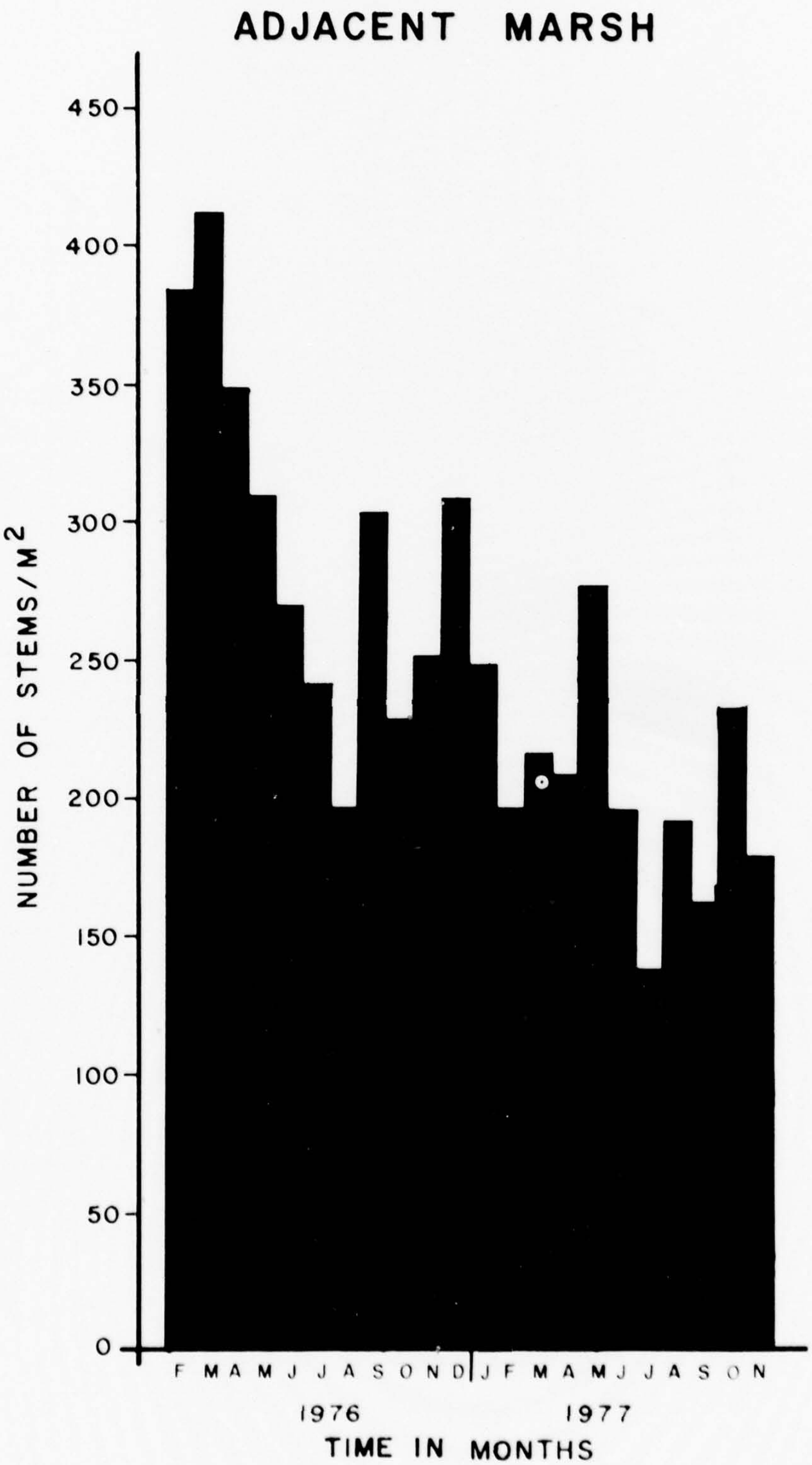


Figure 26. *S. alterniflora* culm density in adjacent marsh control areas.

TABLE 3

Significance of Treatments from the Analysis of Variance for Dependent Variables in the Marsh Smothering Enclosures

				MARSH SNAILS	
Treatment	Live Culms /m^2	Live Crabs /m^2	Crab Burrows /m^2	*Littorina irrorata* /m^2	*Melampus bidentatus* /m^2
Height	****	****	****	****	****
Soil	****	****	****	NS	NS
Height x Soil	****	****	****	NS	NS
Month	****	NS	NS	***	****
Height x Month	****	NS	NS	****	****
Soil x Month	**	NS	NS	NS	NS
Height x Soil x Month	****	NS	***	NS	NS

Probability level: NS = not significant * = 0.05 ** = 0.01 *** = 0.001 **** = 0.0001.

interval. The mean culm density for the 8 through 61 cm enclosure heights were significantly different from each other (Table 4). The 91 cm enclosure fill density was significantly different from all other heights except 61 cm. The orderly gradation of decreasing culm density with the increasing fill depth, illustrated the primary importance of fill depth indetermining recovery of a marsh. Culm densities recorded for the 61 and 91 cm enclosure heights were partly the result of tall culms protruding through the surface of the fill and partly from *Spartina alterniflora* seedlings being established via windborne seeds or, for the November filling date, from seed heads which protruded the surface of the fill. Culm densities resulting from such circumstances were not a true indicator of marsh recovery from a filling operation but suggested the ability of *Spartina alterniflora* to colonize barren areas resulting from dredged material disposal. Culm density and flowering culm density changes over time for each enclosure height, soil and month are depicted in Appendix B.

38. Significant differences of mean culm density for each soil type are depicted in Table 5. Although the means were similar, the sand and clay dredged material produced the highest culm densities. The sand dredged material yield the second highest density and the clay dredged material produced the lowest mean density. The actual mean differences were not great; however, the lower mean density for the clay dredged material may be indicative of the nearly impenetrable layer formed by the dry clay material. This physical characteristic of the dredged material may have impeded the plant recovery.

39. The next treatment tested was that of month or the time during the growing season best suited to recovery from a filling operation. The beginning of the growing season (February) produced the highest overall culm density with the November filling second and the mid-growing season (July) showing the lowest recovery density. The actual mean differences among the three filling periods was small. The staggered filling dates produced differences in the time available for each treatment to recover; therefore, the February filling had the longest time period in which to manifest a recovery. The different time interval allotted for each filling date to recover may have contributed to the significant differences

TABLE 4

Means of Measured Variables by Enclosure Height

Height (cm)	Live Culms /m^2	Live Crabs /m^2	Crab Burrows /m^2	MARSH SNAILS *Littorina irrorata* /m^2	MARSH SNAILS *Melampus bidentatus* /m^2
8	218 a	3.10 a	24.1 a	0.14 a	4.50 a
15	185 b	0.70 b	8.9 b	0.13 a	2.80 b
23	149 c	0.50 b	7.4 b	0.05 b	0.80 c
30	93 d	0.10 b	1.8 c	0.04 b	0.17 c
61	7 e	0.01 b	0.01 c	0.00 b	0.00 c
91	1 e	0.00 b	0.006 c	0.00 b	0.00 c

Means followed by similar letters were not significantly different at $p = 0.05$ according to Duncan's Multiple Range test.

TABLE 5

Means of Measured Variables by

Soil Type, Month of Smothering and Enclosure Type

SOIL TYPE	Live Culms /m²	Live Crabs /m²	Crab Burrows /m²	MARSH SNAILS *Littorina irrorata* /m²	MARSH SNAILS *Melampus bidentatus* /m²
Sand	108.4 b	0.3 b	1.9 b	0.05 a	1.4 a
Sand and Clay	116.0 a	0.3 b	2.1 b	0.05 a	1.2 a
Clay	101.6 c	1.5 a	17.0 a	0.07 a	1.5 a
MONTH					
February	123.5 a	0.6 a	6.5 a	0.10 a	2.2 a
July	98.1 b	0.7 a	7.5 a	0.02 b	1.3 b
November	102.2 b	0.8 a	7.1 a	0.06 ab	0.2 c
Enclosure Type					
Experimental	109.0 b	0.7 b	7.1 a	0.06 b	1.4 b
Control	189.0 a	2.8 a	9.7 a	0.30 a	4.5 a
Experimental	109.0 b	0.7 b	7.1 a	0.06 a	1.4 b
3m x 3m	234.0 a	3.5 a	16.1 a	0.20 a	17.2 a
Experimental	109.0 b	0.7 b	7.1 b	0.06 b	1.4 b
Adjacent Marsh	201.0 a	4.8 a	40.9 a	0.80 a	6.0 a

Means followed by similar letters were not significantly different at $p = 0.05$ according to Duncan's Multiple Range test.

described by the model. Further investigation by way of density comparisons to control areas was required to determine more accurately the time interval necessary to full recovery.

40. The combinations of the treatments of height, soil and month all showed significant differences among mean culm densities. As indicated previously, actual mean differences were small for those interactions including soil and month (Appendix A). The density differences were most pronounced when described by height.

Live Crab and Crab Burrow Density

41. The significant treatments from the analysis of variance for live crabs and crab burrow densities are found in Table 3. The treatments of height, soil and height x soil were significant for both live crabs and crab burrows. The favorable comparison of the models derived from the two different measures of crab activity suggested both to be reasonable estimates of crab presence and activity.

42. Differences in enclosure height yielded significant differences in live crab and crab burrow density (Table 4). The 8 cm enclosures had a mean crab and crab burrow density significantly higher than any other height. For live crab density the 15 through 91 cm enclosures showed significantly lower mean densities than the 8 cm enclosures and crab burrow density was significantly lower for the 30 through 91 cm enclosure heights. Immediately after filling with dredged material, all heights of enclosures displayed burrowing activity, however, the heights of 30 cm and higher lacked any protective vegetation or surface root mat necessary to maintain a moist surface soil layer, thus the surface layers quickly dessicated and the collapsing burrows left the crabs stranded at the surface. Large numbers of dead crabs were seen at the tops of the taller enclosures several days after filling. In the shorter enclosures, sufficient moisture from the underlying marsh and from tidal waters flooding the enclosures maintained the soil moisture such that the crabs were able to survive. Large cracks in the clay substrate provided easy access to deep, cool areas suitable for the survival of the crabs. These

special conditions contributed to the continued survival of the crabs in the taller enclosures for the clay dredged material.

43. The second significant treatment was that of soil. The physical dessication of the upper surface layers of dredged material was directly related to height above the marsh surface; however, all the dredged material types were not equally susceptible to the rapid drying. Both the sand and the sand and clay mixture dried very quickly leaving crumbled burrows and crabs trapped on the surface. The clay dredged material retained moisture and remained consolidated much longer thus providing a more favorable substrate for crab burrows. In addition to being a better burrowing substrate, the clay dredged material was also compatible in terms of particle size distribution with the underlying marsh soil. The major crab population before filling was *Uca pugnax*, the mud fiddler. *Uca pugnax* have mouthparts adapted to feeding from silt and clay particles and thus were best adapted to surviving in a comparable substrate. Even if these mud fiddler crabs were able to survive in the sandy dredged materials, they would have likely starved, lacking the ability to feed in those substrates.

44. The superiority of the clay dredged material in maintaining a crab population was documented in the analysis of variance for the soil treatment. The mean crab burrow density for the clay dredged material was significantly higher than either of the sand dredged materials (Table 5). Crab burrow densities in enclosures with 30 cm or less of dredged material were most abundant in the clay dredged material (Appendix A). The 8 and 15 cm enclosures were the only heights having any appreciable crab burrow density for the sandy dredged materials. Extremely low crab burrow densities were recorded for even the 8 and 15 cm enclosures containing the sandy dredged materials for nearly a year after filling. During this time the increased culm densities of *Spartina alterniflora*, and associated canopy provided a trap for sediments carried over the plots at high tide and fostered a renewed microbial population. These changes of the dredged material surface attracted greater numbers of *Uca pugilator* and *Sesarma reticulatum* to the area. Changes such as these document the importance of the dredged material in determining crab

distribution. Inspection of the means of crab burrow densities at the various enclosure heights documented a strong relationship to enclosure height as did the culm density. It was not clear from this analysis whether the crab burrow densities decrease with enclosure height was a function of culm density or if both measurements are similarily related to elevational changes.

45. The remaining treatment combinations including month (Table 3) showed no significant differences. The effect of month of filling was not great enough to produce any significant differences in crab burrow densities singularly or in combination. Live crab and crab burrow density changes with time in each of the experimental and control areas are depicted in Appendix B.

Marsh Snail Density

46. The model constructed to test the treatments of height, soil and month was similar to those previously discussed except that significant differences attributable to the treatments were measured in terms of snail population densities. The first model considered the population density of *Littorina irrorata*. The population densities recorded in the experimental enclosures never equaled the densities of surrounding marsh areas. The densities of *Littorina irrorata* were lower in 1977 than had been in 1976 soon after the filling operations. The reason for the decline is not clear, but may be due to the extremely cold winter of 1977 and not to experimental treatments since adjacent marsh populations were also low.

47. The first treatment tested (Table 3) was the impact of different depths of dredged material on the snail populations. *Littorina irrorata* had significant differences in population density with height. The mean snail densities for 8 cm and the 15 cm enclosures were not significantly different, however, both were significantly higher than either the 23 cm or the 30 cm enclosures (Table 4). The 61 and 91 cm enclosures had no *Littorina irrorata* at any time after the filling operation. The density values were low for all experimental areas, but

the 8 and 15 cm enclosures represented a good potential for marsh periwinkle recovery.

48. The effects of dredged material type (soil) produced no significant difference in mean densities (Table 5). Treatments of month of filling and enclosure height x month of filling showed significant differences. Inspection of the month of filling means revealed February to have the highest mean density of *Littorina irrorata* (Table 5). It should be noted that the *Littorina irrorata* population density followed the same pattern as that of culm density for the month treatment. The snail density means for the month of filling x enclosure height reflected the patterns set forth by enclosure height (decreasing density as height increases) and by month of smothering (February attained highest density). The inclusion of soil type was ineffective in yielding any significant difference among *Littorina irrorata* density means.

49. The model for *Littorina irrorata* followed the pattern of significant treatments similar to that of culm density. This indicated either the dependence of marsh plant culm density and marsh periwinkle density upon the significant treatments or the dependence of the snail population upon the surviving vegetation. The latter was most probably the case in light of the feeding habits of *Littorina irrorata* (Smalley 1958).

50. The other snail population monitored was *Melampus bidentatus*, the coffee bean snail. Population densities for the coffee bean snail in adjacent marshes were much higher than the marsh periwinkle. *Melampus bidentatus* were observed primarily on the dead portions of plant stalks or on the marsh surface. Inspection of the dead sheaths of a number of live *Spartina alterniflora* culms revealed the occasional occurrence of a number of (5-10) of very small *Melampus bidentatus* snails imbedded in the sheaths. The population density counts from each of the enclosures did not include the inspection and subsequent enumeration of snails embedded in the sheaths. Only those snails observed occupying surface areas were included. The lengthy time required and possible physical damage to the culms warranted a superficial monitoring technique.

51. The treatment of enclosure height yielded significant differ-

ences in mean densities of *Melampus bidentatus* (Table 3). The snail densities at the 8 and 15 cm filling depths were significantly higher than the taller enclosures (Table 4). Previous observations suggested the frequent occurrence of *Melampus bidentatus* on the marsh surface to be related to the moist microclimate associated with the marsh vegetation and daily tidal inundation. The absence of this microclimate in the 23 and 30 cm enclosures suggested an explanation for the attenuated snail densities. As with *Littorina irrorata*, no *Melampus bidentatus* survived in the 61 and 91 cm enclosure heights.

52. The treatments of dredged material type and dredged material x enclosure height were not significant (Table 5) for *Melampus bidentatus* density; however, the treatments of month and month x enclosure height were significant at the 0.0001 level. The mean snail densities for filling month were February ($2.2/m^2$), July ($1.3/m^2$) and November ($0.2/m^2$). The population densities for *Melampus bidentatus* were ordered differently from the marsh periwinkle and seemed to be more a function of time than dependency upon culm density. Mean differences for the month x enclosure height reflected the time factor expressed in the month means in that for every height the February filling had the maximum density and the October filling the minimum density (Appendix A). *Littorina irrorata* and *Melampus bidentatus* density changes with time for each treatment combination are depicted in Appendix B.

Enclosure Controls

53. Using data from the same time period as the previous models (November 1976 through November 1977) an analysis of variance was performed for all control enclosures and all experimental enclosures. Control enclosures included 3 replicates of each enclosure height and were unfilled 0.656 m^2 enclosures. Experimental enclosures consisted of all filled enclosures. The treatment term for the model was the enclosure type. A complete summary of the analysis of variance can be found in Appendix A.

54. The first variable, culm density, was significant at the 0.0001

level. The control mean culm density of $189.5/m^2$ was significantly higher than the experimental mean of $109/m^2$ (Table 5). This evaluation suggested that the experimental treatments of filling had in fact reduced culm density. Live crab density for control areas was significantly higher than crab densities recorded for experimental areas. Crab burrow densities for control and experimental areas were not significantly different at the 0.05 level. The crab burrow densities of $9.7/m^2$ (control) and $7.1/m^2$ (experimental) exemplifies the ability of fiddler and square-back crabs to withstand and recolonize areas perturbed by dredged material deposition. Significantly higher mean densities were exhibited by the marsh periwinkle (*Littorina irrorata*) and coffee bean snail (*Melampus bidentatus*) for control enclosures than for experimental enclosures (Table 5). The comparison of control enclosures to experimental enclosures by height confirmed the reduction of all measured populations except crab burrow density after deposition of dredged material (Appendix A).

Adjacent Marsh Controls

55. A summary of the analysis of variance and mean densities for each dependent variable for experimental and adjacent marsh areas is found in Appendix A. Significant differences for culm densities in experimental enclosures and adjacent marsh areas demonstrated the reduction of culm densities by the experimental treatments (Table 5). Mean culm density for enclosure controls $(189/m^2)$ was slightly lower than the culm density for the adjacent marsh controls $(201/m^2)$ suggesting the possibility of the enclosures reducing culm densities slightly. A comparison of enclosure controls by enclosure height and the adjacent marsh controls revealed only the 61 and 91 cm enclosure controls to have lower culm densities than the adjacent marsh. Live crab densities and crab burrow densities were significantly different for experimental and natural marsh areas. Live crab densities of $0.9/m^2$ for experimental and $4.8/m^2$ for adjacent marshes and crab burrow densities of $7.2/m^2$ for experimental and $40.9/m^2$ for adjacent marshes, illustrated a large de-

crease in the crab populations in the experimental enclosures. Significant differences in mean population densities of *Littorina irrorata* existed between the experimental enclosures ($0.09/m^2$) and the adjacent marsh areas ($0.75/m^2$). *Melampus bidentatus* showed significant differences in mean density for experimental enclosures ($1.7/m^2$) and adjacent marsh areas ($6.0/m^2$). The adjacent marsh controls population densities for both *Littorina irrorata* and *Melampus bidentatus* were higher than the densities recorded for the enclosure controls suggesting the enclosures had affected the snail population densities.

3m x 3m Enclosure Controls

56. The analysis of variance yielded significant differences for means of culm, live crabs, and *Melampus bidentatus* population densities between experimental enclosures and 3m x 3m enclosure controls (Appendix A). The culm density for the 3m x 3m enclosure controls was similar to both the adjacent marsh and enclosure controls suggesting that the 3m x 3m enclosure was not affecting the culm density. Live crab density produced significant mean density differences between the 3m x 3m enclosures and the experimental enclosures (Table 5). The experimental enclosures mean crab density ($0.9/m^2$) and the 3m x 3m enclosure control mean crab density ($3.5/m^2$) exemplified the differences suggested by the model. Crab burrow densities were not significantly different between experimental and 3m x 3m enclosures. The mean burrow density was greater for the 3m x 3m enclosures than for experimental enclosures; however, the low number of replicates for the 3m x 3m enclosures negated a significant difference.

57. No significant differences between experimental and 3m x 3m enclosure control means were noted for *Littorina irrorata*. *Melampus bidentatus* had a significantly higher mean density in the 3m x 3m enclosure than in the experimental areas.

58. A comparison of adjacent marsh controls and the 3m x 3m enclosure controls revealed mean plant culm density and *Melampus bidentatus* density were higher for the 3m x 3m enclosure control. The lower

densities of live crabs, crab burrows and *Littorina irrorata* in the 3m x 3m enclosures suggested a possible restriction of normal population movements had been imposed by the enclosure walls.

Summary

59. The effect of the depth of dredged material placed over a marsh was the primary determinator of the degree of marsh recovery as measured by culm density. The effect of month of deposition produced highest culm densities for the February filling. The month of deposition resulted in different recovery intervals for each filling month and may have been more of a factor in the density differences than the treatment itself. The treatment of dredged material type showed sand and clay to have the greatest culm density. The actual differences between culm density means for each of the dredged material types was small suggesting a longer recovery period may negate any differences.

60. Crab burrow density and live crab density both documented enclosure height and soil as the significant treatments controlling fiddler and square back crab populations. Initially, the inability of the crabs to maintain burrows in the sandy dredged materials limited their distribution. As the surface consistancy of these dredged materials was changed by the accumulation of silt and clay particles, the crab populations were able to recolonize the areas. The similarity of the clay dredged material to the underlying marsh resulted in significantly higher burrow and live crab densities at all enclosure heights for the clay dredged material. The initial population of *Uca pugnax* crabs was replaced by *Uca pugilator* and *Sesarma reticulatum* in the two sandy dredged materials. Crab burrow density varied inversely to enclosure height, much the same as culm density. Live crab and crab burrow densities failed to describe any significant differences to month of smothering.

61. The two marsh snails exhibited similar significance to the treatment interactions, namely; enclosure height, month, and enclosure height x month. Culm density was significant for the same treatment

interactions suggesting the dependence of both species of snails upon the presence of sufficient vegetation to provide habitat for their survival. Dredged material type was a significant factor in determining crab burrow density but failed to produce any significant differences for either snail population. This illustrated different environmental factors to be controlling snail populations than were controlling crab populations. Lower overall mean density for both species of snails in the experimental as well as control areas in 1977 indicated factors other than the experimental treatments to account for the decreases.

62. A comparison of the three control types revealed both the enclosure controls of 30 cm or less and the 3m x 3m enclosure controls to have slightly higher culm densities than the adjacent marsh controls. This may be an indication of a container effect causing the higher density of *Spartina alterniflora* culms. Enclosure controls of 61 and 91 cm exhibited attenuated culm densities probably due to the restriction of incident sun light. The adjacent marsh control areas yielded higher densities of live crabs, crab burrow and *Littorina irrorata* than either size of enclosure controls. The 3m x 3m enclosure control had higher densities of *Melampus bidentatus* than either the adjacent marsh or the enclosure controls. The restrictive nature of the enclosure walls was least evident for the *Spartina alterniflora* culm density and most evident in the mobile populations of crabs and snails.

PART IV: PLANT PERFORMANCE (BIOMASS)

63. This part deals with biomass measurements estimated from $0.05m^2$ quadrats placed within each experimental enclosure and all control areas. Biomass was estimated using the linear regression equations described in the Materials and Methods section (Part II) utilizing the sum of the heights (cm) of all live or dead culms found within the quadrats. Live and dead culm densities were also monitored within each quadrat. The quadrats were stationary and were measured in April 1977 and again in November 1977. All biomass values were expressed as gdw/m^2 and culm densities as culms $/m^2$.

64. The biomass estimates for the control enclosures and adjacent marsh controls were estimated using the regression equations as were the experimental enclosures, thus, comparisons among the three would provide a relative indicator of recovery success based on biomass.

Standing Crop Biomass

April 1977

65. The enclosures filled with the sand dredged material monitored in April 1977, are found in Table 6. Differences of mean standing crop biomass (of combined live and dead tissue) by height class revealed the 8 and 15 cm enclosures to be similar for each of the filling months. The 23 and 30 cm enclosures showed live and dead biomass declined with increased enclosure height and declined with later filling months. Except for the February fill, there was pronounced reduction in biomass in the 23 cm and taller enclosures. Figure 27 depicted live and dead standing crop biomass for the *Spartina alterniflora* marsh adjacent to the study area determined by destructive harvest techniques. The live or dead standing crop

TABLE 6

MARSH SMOTHERING EXPERIMENTAL ENCLOSURES

ESTIMATED COMBINED LIVE AND DEAD STANDING CROP BIOMASS

AND CULM DENSITY FROM PERMANENT 0.05 m^2 QUADRATS

APRIL 1977

Substrate type:	SAND					
Month of filling:	FEBRUARY		JULY		NOVEMBER	
Depth of fill	mean culm density/m^2	mean standing crop biomass gdw/m^2	mean culm density/m^2	mean standing crop biomass gdw/m^2	mean culm density/m^2	mean standing crop biomass gdw/m^2
8 cm.	260	812.9	340	896.3	320	703.3
15 cm.	326	1001.6	220	630.7	200	708.4
23 cm.	220	748.3	126	426.5	130	247.8
30 cm.	180	494.0	70	288.2	60	122.4
61 cm.	0	0	0	0	0	0
91 cm.	120	297.1	0	0	0	0

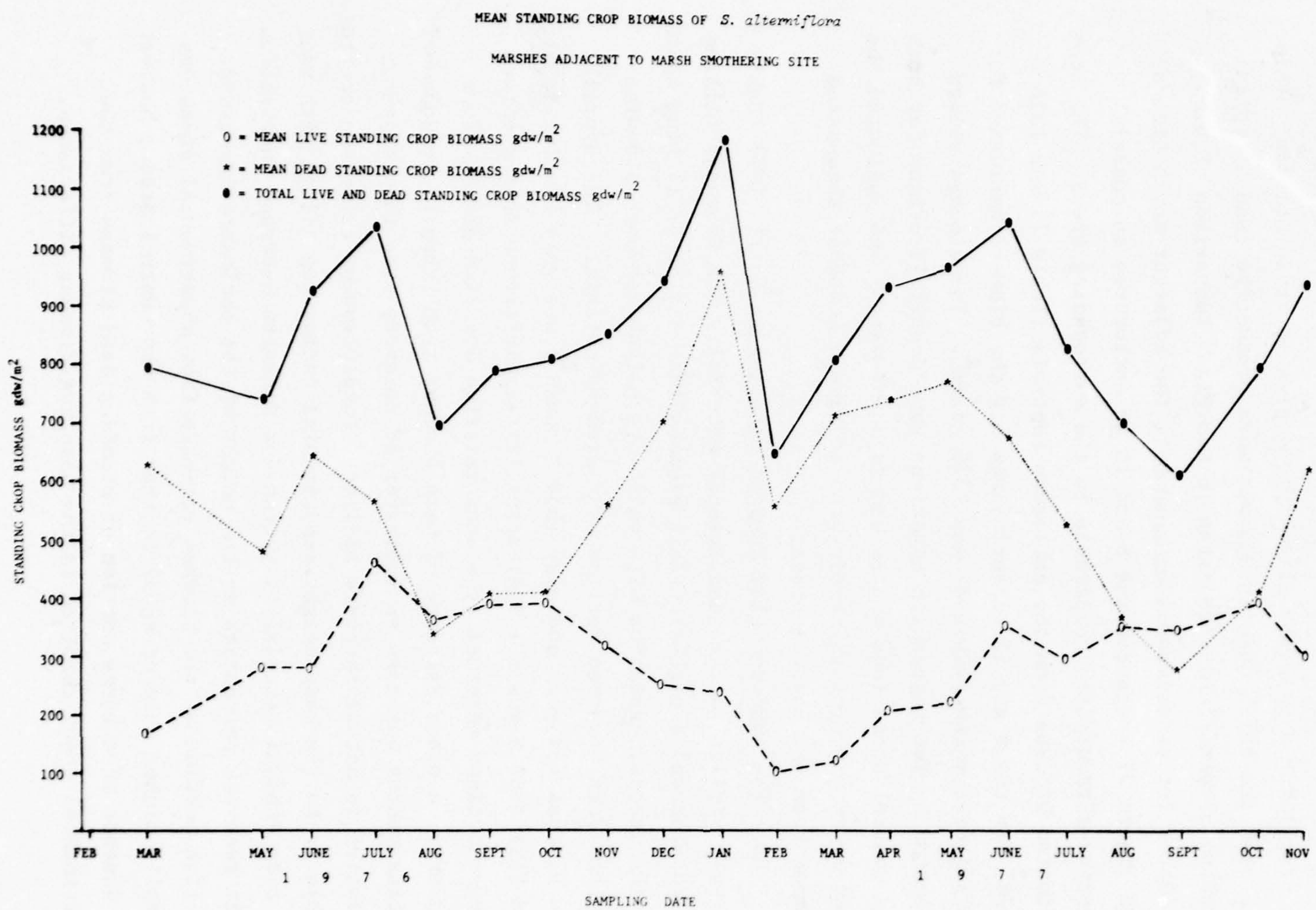


Figure 27. Live and dead standing crop biomass for S. alterniflora marshes adjacent to Marsh Smothering site.

biomass was higher than biomass values obtained by Gallagher et al. (in press) for a *Spartina alterniflora* high marsh in Georgia. This suggested the marsh under study was more productive than a typical *Spartina alterniflora* high marsh in Georgia. Comparison of biomass estimates for experimental enclosures to the adjacent marsh biomass from Figure 27 suggested the 8 and 15 cm enclosures to contain *Spartina alterniflora* comparable to the surrounding areas. The mean estimated biomass from the enclosure controls (Table 7) was 1316 gdw/m^2 for the 8 and 15 cm enclosures and the biomass estimated for the adjacent marsh (Table 8) was 1326 gdw/m^2. The biomass values estimated by the regression equations were nearly identical for both type control areas (enclosures and adjacent marsh) and indicated the 8 and 15 cm experimental enclosures to have a somewhat attenuated biomass from the control areas.

66. The sand and clay dredged material in April 1977 (Table 9), was very similar to the sand dredged material. The February filling period produced a higher overall biomass than any other filling month but the general gradation with enclosure height was more stepwise than had been observed for the sand dredged material. The overall mean biomass for sand and clay (559.9 gdw/m^2) was very similar to the sand fill (567.5 gdw/m^2) indicating little difference in the effect of each dredged material type upon relative *Spartina alterniflora* recovery. A minor decrease of mean biomass from February to November filling months was more an indicator of recovery time than seasonal variation in actual recovery ability. Comparison of enclosure controls (Table 7) to the same height experimental enclosures filled with sand and clay dredged material illustrated a definite decrease in relative plant recovery percentage as the height of the enclosure increased. The live portion of the biomass estimate from experimental areas was normally higher than or equal to that from the control areas, however the absence of a large portion of standing dead biomass from the experimental areas resulted in the observed biomass differences.

TABLE 7

MARSH SMOTHERING CONTROL ENCLOSURES

ESTIMATED STANDING CROP BIOMASS AND CULM DENSITY FROM PERMANENT 0.05 m^2 QUADRATS

	APRIL 1977		NOVEMBER 1977	
Depth of fill	mean culm density /m^2	mean standing crop biomass gdw/m^2	mean culm density /m^2	mean standing* crop biomass gdw/m^2
8 cm.	310	1234.0	170	749.0
15 cm.	327	1397.3	313	953.3
23 cm.	500	1170.3	566	988.9
30 cm.	326	1410.5	356	1212.7
61 cm.	293	1313.8	340	1087.3
91 cm.	127	991.2	87	602.4

TABLE 8

MARSH SMOTHERING ADJACENT MARSH CONTROLS

ESTIMATED STANDING CROP BIOMASS AND CULM DENSITY FROM 0.05 m^2 QUADRATS

	APRIL 1977		NOVEMBER 1977	
Location	mean culm density /m^2	mean standing crop biomass gdw/m^2	mean culm density /m^2	mean standing crop biomass gdw/m^2
East marsh	520	978.5	880	1112.0
North marsh	340	1429.4	450	1296.0
West marsh	360	1571.2	650	1833.9
East 3m x 3m Enclosures	440	1437.9	640	1488.4
West 3m x 3m Enclosures	670	1376.6	610	1228.5

TABLE 9

MARSH SMOTHERING EXPERIMENTAL ENCLOSURES

ESTIMATED COMBINED LIVE AND DEAD STANDING CROP BIOMASS

AND CULM DENSITY FROM PERMANENT 0.05 m^2 QUADRATS

APRIL 1977

Substrate type :	SAND AND CLAY					
Month of filling:	FEBRUARY		JULY		NOVEMBER	
Depth of fill	mean culm density $/m^2$	mean standing crop biomass gdw/m^2	mean culm density $/m^2$	mean standing crop biomass gdw/m^2	mean culm density $/m^2$	mean standing crop biomass gdw/m^2
8 cm.	340	960.4	340	800.7	460	1114.9
15 cm.	213	600.9	193	577.4	300	421.7
23 cm.	193	950.5	120	367.4	230	285.0
30 cm.	100	242.2	67	162.6	120	234.8

67. Experimental enclosures smothered with clay dredged material varied little in terms of overall mean biomass (528.9 gdw/m^2) from the two sandy dredged materials (Table 10). The 8 and 15 cm enclosures attained the highest biomass values for the clay dredged material for each of the three filling months. The 30 cm enclosures had a lower mean biomass for the clay dredged material than for the sandy dredged materials. The clay substrate consolidated and dried to a hard block covering the marsh, thus providing more resistance to rhizome penetration than the sandy dredged materials and reducing overall biomass. The mean biomass of the 8 and 15 cm enclosures for February filling was twice that of either the July or November filling. A similar trend was evident with the sandy dredged materials, but was not manifest to such a degree. The effect of time on plant biomass recovery was evident by the successive increases in combined live and dead plant biomass from the February through November fillings.

68. A comparison of the experimental enclosures to both the adjacent marsh controls and the enclosure controls showed the much lower overall biomass attained by the experimental areas. The 8 and 15 cm enclosures from the February filling of the clay substrate approached the biomass values estimated for both control areas.

<u>November 1977</u>

69. The combined live and dead standing crop biomass of the adjacent *Spartina alterniflora* marshes in November was a peak period as had been the case for the April sampling (Figure 27). Consequently, the total standing crop biomass at the time of both sampling intervals was essentially identical (April, 950.4 gdw/m^2 and November, 948.1 gdw/m^2). Therefore changes of overall plant biomass from the April to November sampling in the experimental enclosures was attributed to the recovery process and not to natural seasonal fluctuations of the *Spartina alterniflora* standing crop biomass.

70. The November monitoring of the sand filled experimental enclosures (Table 11) revealed an overall mean biomass increase of

TABLE 10

MARSH SMOTHERING EXPERIMENTAL ENCLOSURES

ESTIMATED COMBINED LIVE AND DEAD STANDING CROP BIOMASS

AND CULM DENSITY FROM PERMANENT 0.05 m^2 QUADRATS

APRIL 1977

Substrate type :	CLAY					
Month of filling:	FEBRUARY		JULY		NOVEMBER	
Depth of fill	mean culm density /m^2	mean standing* crop biomass gdw/m^2	mean culm density /m^2	mean standing crop biomass gdw/m^2	mean culm density /m^2	mean standing crop biomass gdw/m^2
8 cm.	293	1052.6	173	507.2	320	725.7
15 cm.	286	1216.3	190	570.0	120	305.5
23 cm.	166	475.5	150	486.5	180	308.6
30 cm.	126	476.7	66	165.0	30	57.0

TABLE 11

MARSH SMOTHERING EXPERIMENTAL ENCLOSURES

ESTIMATED COMBINED LIVE AND DEAD STANDING CROP BIOMASS

AND CULM DENSITY FROM PERMANENT 0.05 m^2 QUADRATS

NOVEMBER 1977

Substrate type :	SAND					
Month of filling:	FEBRUARY		JULY		NOVEMBER	
Depth of fill	mean culm density /m^2	mean standing crop biomass gdw/m^2	mean culm density /m^2	mean standing crop biomass gdw/m^2	mean culm density /m^2	mean standing crop biomass gdw/m^2
8 cm.	233	682.8	240	732.9	200	552.5
15 cm.	260	781.0	240	661.5	230	820.6
23 cm.	213	799.1	153	642.6	160	584.4
30 cm.	153	609.3	270	1281.2	70	340.0

139.8 gdw/m^2 over the April sampling period. The increase in biomass was the result of significant gains in biomass for the 23 and 30 cm enclosures for all filling dates. As a result of the increase in biomass, the February and July filling dates failed to manifest biomass differences by enclosure height less than 30 cm. This suggested that the *Spartina alterniflora* which had survived the 23 and 30 cm fillings was now as healthy as the *Spartina alterniflora* in the shallower fills. The enclosures filled in November made biomass gains of over 125 gdw/m^2 but biomass differentiation by enclosure height was still evident. The biomass means by filling month showed February and July to be similar with November still lagging in biomass. The mean biomass of the experimental enclosures was less than the control enclosures and the adjacent marsh controls suggesting full recovery had not yet taken place.

71. The November monitoring of the experimental enclosures filled with sand and clay dredged material was found in Table 12. The overall mean biomass increased from 559.9 gdw/m^2 in April to 805.8 gdw/m^2 in November. This substantial gain resulted from large biomass increases in the 23 and 30 cm enclosures. The mean biomass for each filling date was similar indicating an accelerated growth rate experienced by the July and November fills during the 1977 growing season. The mean biomass for each height of enclosures was no longer significantly different, as had been the case with the sand dredged material. Comparison of the experimental mean combined live and dead plant biomass to the enclosure controls yielded a 126.5 gdw/m^2 difference with the enclosure controls still slightly greater. The adjacent marsh controls mean biomass was substantially greater than the experimental enclosures. Overall the sand and clay dredged material had a higher mean biomass (805.8 gdw/m^2) than did the sand dredged material (707.3 gdw/m^2).

72. Evaluation of the clay substrate for the November interval (Table 13) showed another large overall mean biomass increase from the April sampling period. Most of the biomass increases occurred in the

TABLE 12

MARSH SMOTHERING EXPERIMENTAL ENCLOSURES

ESTIMATED COMBINED LIVE AND DEAD STANDING CROP BIOMASS

AND CULM DENSITY FROM PERMANENT 0.05 m^2 QUADRATS

NOVEMBER 1977

Substrate type :	SAND AND CLAY					
Month of filling:	FEBRUARY		JULY		NOVEMBER	
Depth of fill	mean culm density /m^2	mean standing crop biomass gdw/m^2	mean culm density /m^2	mean standing crop biomass gdw/m^2	mean culm density /m^2	mean standing crop biomass gdw/m^2
8 cm.	266	870.8	200	557.4	320	792.8
15 cm.	145	672.4	233	1271.3	190	407.7
23 cm.	233	857.4	487	960.6	405	819.5
30 cm.	340	981.5	110	518.4	230	960.0

TABLE 13

MARSH SMOTHERING EXPERIMENTAL ENCLOSURES

ESTIMATED COMBINED LIVE AND DEAD STANDING CROP BIOMASS

AND CULM DENSITY FROM PERMANENT 0.05 m^2 QUADRATS

NOVEMBER 1977

Substrate type :	CLAY					
Month of filling:	FEBRUARY		JULY		NOVEMBER	
Depth of fill	mean culm density /m^2	mean standing crop biomass gdw/m^2	mean culm density /m^2	mean standing crop biomass gdw/m^2	mean culm density /m^2	mean standing crop biomass gdw/m^2
8 cm.	153	667.5	206	774.7	220	726.6
15 cm.	240	877.5	260	849.7	230	953.0
23 cm.	446	1176.5	286	1022.6	280	1046.2
30 cm.	293	1142.6	193	826.8	160	644.0

23 and 30 cm enclosures with many of the shallow fills decreasing in biomass. The differentiation of filling month by biomass was not as pronounced as had been, but the February fill still attained the greatest mean biomass. The mean overall biomass for the clay substrate (892.3 gdw/m^2) was the largest of the three dredged materials tested and was only 40 gdw/m^2 less than the mean biomass for the enclosure controls. A significant gap still existed between the adjacent marsh controls and the clay substrate suggesting the experimental treatments had not attained a climax stage.

73. The enclosure controls (Table 7) decreased in mean overall biomass from 1316 gdw/m^2 in April to 932.3 gdw/m^2 in November. The major decreases were manifested in the shallow fills as was the case with the experimental enclosures. These trends indicated the possibility of a container effect beginning to develop. All heights of enclosure controls decreased in mean biomass indicating a factor common to all to be the cause. The adjacent marsh controls showed an increase in mean biomass and the 3m x 3m enclosures remained about the same (Table 8). The stability of the 3m x 3m enclosure control mean biomass, and the decrease of mean biomass experienced in the smaller enclosure controls, suggested the larger 3m x 3m enclosure controls were not subject to the container effect that the smaller enclosures demonstrated.

Biomass Models

74. Biomass estimates from April and November 1977 experimental and control areas were pooled and an analysis of variance performed. Enclosures exhibiting no plant recovery were treated as missing values rather than zero values. This maintained the actual biomass and culm density values of the remaining enclosures and provided an equitable comparator to the control areas. The treatments of height, soil and month were identical to those described for culm density. The treatment labeled control tested the potential difference between control

and experimental enclosures. The treatments of soil and month were not applicable to the control areas therefore were not included in treatment interactions involving the control treatment. Biomass and culm densities were calculated from stationary $0.05m^2$ circular quadrats positioned in each experimental and control enclosure.

75. The significant treatments from the analysis of variance for biomass and culm density estimates (Appendix C) can be found in Table 14. Live biomass and live and dead culm density showed significantly different means among height treatments (Table 15). The live biomass for the 61 cm enclosures was significantly higher than any other enclosure, however, the vegetation measured was the result of naturally seeded *Spartina alterniflora* inhabiting the filled enclosures. This was not a response to the experimental treatment of height. The highest mean live biomass developed in the 8, 15, and 23 cm enclosure heights. The 8 and 15 cm live biomass means were slightly less than the 685 gdw/m^2 mean for the adjacent marsh. The difference between the experimental and adjacent marsh mean live biomass was within the limits of sampling error and indicated recovery had progressed to near normal biomass levels. The 30 and 91 cm enclosures were only about half of the adjacent marsh live biomass, however the 91 cm enclosures measured 3 occurrences of a few culms protruding the dredged material along the edge of the enclosure and one area exhibiting natural seeding. Neither response was a true indicator of recovery from the 91 cm filling operation.

76. Live culm densities (Table 15) described the 8, 15 and 23 cm enclosures to be significantly greated than the 30 cm enclosures. This relationship was consistant with the culm densities enumerated in Part III. The 61 and 91 cm enclosures were not discussed since the response was not a true indicator of recovery (see previous paragraph). The 30 cm enclosures had a significantly higher mean dead culm density than the 8 or 15 cm enclosures. The greater density of standing dead culms indicated the 30 cm enclosures failed to receive frequent tidal

TABLE 14

Significance of Treatments from the Analysis of Variance for Biomass Measurements in the Marsh Smothering Enclosures

TREATMENT	Dead Biomass gdw/m^2	Live Biomass gdw/m^2	Total Biomass gdw/m^2	Live Culms /m^2	Dead Culms /m^2
Height	NS	*	NS	****	**
Soil	NS	**	**	**	NS
Height x Soil	NS	NS	NS	**	NS
Month	***	NS	**	NS	**
Height x Month	NS	NS	NS	NS	NS
Soil x Month	NS	NS	NS	NS	NS
Height x Soil x Month	NS	NS	NS	NS	NS
Control	****	****	****	****	****
Height x Control	NS	NS	NS	**	NS

Probability level: NS = not significant * = 0.05 ** = 0.01 *** = 0.001 **** = 0.0001.

TABLE 15

Biomass and Culm Density Means for Marsh Smothering Enclosures

HEIGHT (cm)	Dead Biomass gdw/m^2	Live Biomass gdw/m^2	Total Biomass gdw/m^2	Dead Culms /m^2	Live Culms /m^2
8	149.2 b	625.1 b	774.3 b	89.1 b	264.8 a
15	140.3 b	616.0 b	756.4 b	94.8 b	242.8 a
23	184.1 ab	523.4 b	707.6 bc	149.4 ab	263.0 a
30	199.9 ab	390.1 c	590.0 c	157.6 a	175.5 b
61	295.0 ab	904.9 a	1199.9 a	150.0 ab	316.6 a
91	310.8 a	371.0 c	681.9 c	128.5 ab	108.5 b

Means followed by similar letters were not significantly different at $p = 0.05$ according to Duncan's Multiple Range test.

inundation necessary to remove the dead portions. The 23 cm enclosures had the second highest dead culm density which was approximately 40% higher than the 8 and 15 cm enclosures. The 61 and 91 cm enclosures exhibited high dead culm densities for the limited vegetation found in those enclosures.

77. The treatment of soil type exhibited significant mean differences for live and total biomass and live culm density (Table 14). Table 16 showed the clay substrate to support a significantly greater live and total biomass than either the sand or sand and clay dredged materials. The differentiation between dredged material types was not as pronounced for live culm density as had been for biomass. The clay dredged material had a significantly higher live stem density than the sand dredged material. The actual difference in live culm densities among the dredged material types ranged from 210-252 culms/m^2 illustrating small differences which may only require more recovery time to equilize. This was much the same trend described by the culm density model in Part IV. After consolidation the clay dredged material afforded the greatest physical barrier to rhizome spread, however after establishment of a few shoots from the underlying marsh, tiller production from these shoots was much faster and denser in the clay dredged material than in the sandy dredged materials.

78. The interaction of the height x soil treatments demonstrated significant mean difference for live culm density. The remaining measurements of the plant population failed to reach the significance criterion. The lowest live culm densities were associated with the two sandy dredged materials in the 91 cm enclosures.

79. The next treatment, month of filling, produced significant mean differences for dead biomass, total biomass, and dead culm density (Table 14). Dead and total biomass means were significantly lower for the July filling, (Table 16). Dead culm density was also significantly lower for the July filling. Live biomass and live culm density means although not significant were lowest for the July filling. This trend

TABLE 16

Biomass and Culm Density Means by
Soil Type, Month of Smothering and Enclosure Type

SOIL TYPE	Dead Biomass gdw/m^2	Live Biomass gdw/m^2	Total Biomass gdw/m^2	Live Culm /m^2	Dead Culm /m^2
Sand	187 a	494 b	680 b	210 b	134 a
Sand and Clay	160 a	514 b	674 b	245 ab	120 a
Clay	184 a	624 a	808 a	252 a	134 a
MONTH					
February	206 a	555 a	761 a	241 a	128 a
July	102 b	501 a	603 b	199 b	73 b
November	214 a	564 a	779 a	261 a	152 a
ENCLOSURE TYPE					
Control areas	354 a	714 a	1068 a	319 a	187 a
Experimental areas	142 b	508 b	650 b	219 b	104 b

Means followed by similar letters were not significantly different at $p = 0.05$ according to Duncan's Multiple Range test.

indicated the midgrowing season filling operation (July) recovered slower than beginning or end of season smothering operations. The lack of a significant difference for live biomass suggested the July filling was presently equaling the production rate of the other months and the absence of previous growth (dead material) was contributing to the significant differences. This indicated the July filling operation needed a longer recovery interval.

80. The treatment termed control provided a comparison of experimental enclosures (filled) and control enclosures and yielded significant differences for all parameters measured (Table 14). In all cases the means for the control enclosures were significantly higher than the experimental enclosures (Table 16). The experimental enclosures contained approximately 40 percent less biomass and 33 percent less live culms than did the control enclosures.

81. The interaction of the height x control treatments demonstrated significant differences for live culm densities (Table 14). The similarity of experimental and control enclosures in terms of biomass for each height indicated the potential for vegetation to recover to near normal densities after the smothering operation.

Summary

82. The estimated biomass measurements for the experimental and control enclosures revealed differences in biomass were related to smothering depth, dredged material type and month of smothering. The largest mean biomass differences resulted from the depth of smothering. Immediately after smothering, the number of culms and rhizomes able to grow through the dredged material was small. The two sandy dredged materials allowed a higher density of culms to emerge than did the clay dredged material. This density trend continued, however, in terms of biomass the clay dredged material produced higher combined live and dead biomass than did either of the sandy dredged

materials. The more luxuriant growth of *Spartina alterniflora* in the clay dredged material probably was the result of added nutrient from the dredged material. The gradation of biomass production versus depth of dredged material showed 8, 15 and 23 cm enclosure heights to have highest biomass production. The 30 cm enclosures produced significantly less biomass and the 61 and 91 cm enclosure biomass values were the result of naturally seeded *Spartina alterniflora* and therefore not a true indicator of recovery from a smothering operation.

83. Biomass differences related to dredged material type described the clay dredged material to have the highest biomass production with two sandy dredged materials not far behind. The sand dredged material and clay dredged material yielded similar biomass values for dead material with the sand and clay material producing slightly less dead biomass. The lower dead biomass in the sand and clay dredged material suggested attenuated biomass production following the smothering operation as compared to the other two dredged materials.

84. The July filling period yielded significantly less combined biomass than either the February or November filling months. Lower dead biomass values for the July filling indicated the lower overall biomass resulted from less growth the previous year since the standing dead would be an indicator of the previous years growth.

85. Overall biomass increases from April 1977 to November 1977 resulted from substantial increases in the 23 and 30 cm inclosures. The 8 and 15 cm enclosures for all dredged materials maintained lower biomass values than the enclosures controls and adjacent marsh controls. By November 1977, the 8, 15, 23 and 30 cm enclosures contained similar biomass values, however, levels were still lower than control areas.

86. A comparison of adjacent marsh and enclosure control areas revealed the enclosure controls to have an attenuated mean biomass from that of the adjacent marsh areas. In April 1977 the two control types were similar but in November 1977 the control enclosures lacked the recruitment (culm density) and biomass levels of the adjacent

Spartina alterniflora marsh. The disparity between the two control types indicated a possible container effect was beginning in the enclosures. Restriction of tidal inundation, interstitial water movement or incident sunlight were factors associated with the enclosures which may have attributed to the attenuated culm density and biomass in the enclosure controls. The filled enclosures of 8 and 15 cm approximated the biomass and density values of the enclosure controls suggesting the filled enclosures had attained full recovery within the experimental restraints of the enclosures. Biomass estimates using the regression equations for the adjacent marsh were higher than estimates by destructive techniques.

PART V: DREDGED MATERIAL CHEMISTRY

87. The dredged material types were selected to typify the sediments encountered while dredging in the southeast. The sandy dredged materials were indicative of a freshwater delta system or a beach and shoal system. The clay dredged material would better typify the sediments of a tidal marshland system. All three dredged materials were dredged from waterways in the Brunswick, Georgia area.

88. Table 17 describes the particle size distribution of the dredged substrates. The sand and sand and clay dredged materials were similar except for a larger portion of organic material and a higher percentage of silt particles (Gallagher et al. 1977). The sand and clay substrate frequently contained lumps of clay material mixed with the sand. The clay dredged material contained many *Spartina alterniflora* roots and small shells described by the fraction labeled granule. The major portion of the very coarse sand and coarse sand fractions for the clay dredged material contained shell fragments and pieces of root material.

89. Prior to initiation of the filling operation, cores 7.3 cm in diameter and 60 cm deep were taken from the *Spartina alterniflora* marsh adjacent to the proposed study area. Chemical and physical properties of the soil were determined to establish baseline conditions (Tables 18 and 19). Also depicted on the tables was a similar analysis of each of the dredged material types. Of the three dredged materials, the sand materials were poorest in nutrient content as well as cation exchange capacity. The sand and clay dredged material varied somewhat from the sand material in that nutrient levels were generally higher (especially iron and calcium) and the cation exchange capacity was also slightly higher. Neither of the sandy dredged materials resembled the chemical soil properties existing in the *Spartina alterniflora* marsh before the filling operation. The clay substrate was similar to the marsh soil. The comparable nutrient levels as well as cation

TABLE 17

DREDGED MATERIAL SIEVE ANALYSIS

MARSH SMOTHERING EXPERIMENTAL ENCLOSURES

FEBRUARY 1976

PARTICLE SIZE	DESCRIPTION OF FRACTION*	SILTY SAND	SAND	CLAY
GRAINS < 2mm	GRANULE	0.5%	0.1%	21.7%
GRAINS > 1mm < 2mm	VERY COARSE SAND	6.8%	4.6%	12.2%
GRAINS > 500μ < 1mm	COARSE SAND	43.9%	45.1%	13.0%
GRAINS < 500μ	MEDIUM SAND AND SMALLER	48.8%	50.2%	53.1%

* from Buchanan and Kain 1971.

TABLE 18

PHYSICAL ANALYSIS OF MARSH CONTROLS AND DREDGED MATERIAL SUBSTRATES FOR MARSH SMOTHERING SITE

FEBRUARY 1976

Substrate type:	Depth of core (cm.)	pH^w	Eh (mv.)	% H_2O	CEC meg/100g.	% O.M.
East marsh	0-15	7.5	+ 319	30.0	19.27	2.56
East marsh	15-30	7.4	+ 104	55.0	29.08	9.90
East marsh	30-45	7.7	+ 144	62.0	—	13.47
East marsh	45-60	7.6	+ 194	46.0	33.42	6.29
North marsh	0-15	7.7	+ 239	58.0	28.67	13.06
North marsh	15-30	7.7	+ 134	64.0	22.47	13.56
North marsh	30-45	7.9	+ 299	63.0	33.14	13.37
North marsh	45-60	7.8	+ 284	51.0	34.83	8.22
West marsh	0-15	7.9	+ 124	60.0	29.55	13.54
West marsh	15-30	8.0	+ 294	64.0	24.12	15.55
West marsh	30-45	8.0	+ 184	33.0	33.41	4.06
West marsh	45-60	8.2	+ 284	10.0	28.99	1.10
Silty sand	surface	7.8	+ 408	6.0	1.90	—
Clay	surface	7.2	+ 182	51.0	30.20	—
Sand	surface	6.9	+ 406	17.8	0.59	—

pH^w = 1:1 parts distilled water to soil by weight; Eh (mv.)= Redox potential in millivolts; % H_2O = percent water content; CEC = Cation exchange capacity in milliequvalents per 100 grams dry weight of soil sample; % O.M. = percent organic matter.

TABLE 19

MINERAL ANALYSIS OF MARSH CONTROLS AND DREDGED MATERIAL SUBSTRATES FOR MARSH SMOTHERING SITE

FEBRUARY 1976

Substrate type:	Depth of core (cm.)	Fe*	Cu	K	Ca	Mg	Mn	B	S	Co	As	Zn
East marsh	0-15	9.1	0.0	265.0	2980.0	395	10.25	4.10	0.18	1.35	0.90	12.50
East marsh	15-30	0.1	0.0	299.0	4815.0	460	6.70	6.00	0.47	IA	IA	0.25
East marsh	30-45	305.0	0.3	787.5	4460.0	1620	23.75	10.75	0.70	IA	IA	3.60
East marsh	45-60	369.5	0.6	582.5	3145.0	1800	35.00	15.25	0.44	2.40	1.80	2.60
North marsh	0-15	366.0	1.4	890.0	2047.5	1650	17.65	8.75	0.37	IA	IA	7.20
North marsh	15-30	130.0	0.0	982.5	2232.5	670	22.30	13.65	0.48	IA	IA	64.50
North marsh	30-45	151.5	0.0	760.0	2137.5	1740	31.25	9.85	0.62	4.50	IA	6.45
North marsh	45-60	490.5	0.8	198.5	3820.0	1635	68.00	4.25	0.20	1.50	1.30	2.00
West marsh	0-15	610.5	0.7	942.5	2010.0	1810	49.70	12.60	0.51	5.50	5.00	5.70
West marsh	15-30	173.0	0.0	760.0	2247.5	880	12.75	13.10	0.68	IA	IA	5.80
West marsh	30-45	75.5	0.0	425.0	4865.0	815	22.40	6.90	0.34	3.10	1.60	23.00
West marsh	45-60	72.0	0.0	128.0	4980.0	355	11.25	2.20	0.05	1.25	0.70	10.50
Sand & clay	surface	443.5	0.0	21.5	300.0	44	0.00	0.10	0.01	1.25	0.06	17.00
Clay	surface	40.75	0.0	421.5	4375.0	725	36.20	7.50	0.31	2.25	2.85	2.90
Sand	surface	41.67	0.4	8.6	64.3	21	5.25	0.12	0.01	IA	IA	IA

* All values in parts per million. Fe= iron; Cu= copper; K= potassium; Ca= calcium; Mg= magnesium; Mn= manganese; B= boron S= sulfur; Co= cobalt; As= arsenic; Zn= zinc; IA= insufficient amount of sample for analysis.

AD-A063 366 GEORGIA UNIV BRUNSWICK MARINE EXTENSION SERVICE F/G 13/2

THE EFFECTS OF SMOTHERING A 'SPARTINA ALTERNIFLORA' SALT MARSH --ETC(U)

JUL 78 R J REIMOLD, M A HARDISKY, P C ADAMS DACW21-75-C-0074

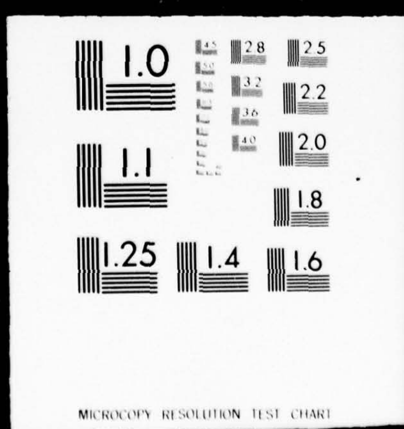
UNCLASSIFIED WES-TR-D-78-38 NL

2 OF 6

AD A063366

2 OF 6

AD
A063366



exchange capacity indicated that areas smothered with the clay substrate might have a distinct survival advantage over those areas smothered with the sandy dredged material. This hypothesis was substantiated in terms of biomass production in Part IV.

90. During the experimental period, dredged material analysis consisted of monitoring changes in the physical properties of the substrate. Following the filling operation, the sandy dredged materials showed some consolidation and drying of the surface layers but overall maintained a texture analogous to that of the filling period (Table 2). The moisture content of the clay was greater than 50% during the filling operation. As the clay dried, it consolidated into a dense block with numerous cracks left by the contaction of the dredged material. In many instances the large cracks in the dried clay afforded the only opportunity for smothered vegetation to gain access to the surface.

91. Other physical properties of the dredged materials included the soil salinity and moisture content. Table 20 described salinity and percent water measurements of the various dredged materials five months after filling for the February filling and several weeks following the July filling. The two sandy dredged materials changed little in either salinity or moisture with time. A slight decrease in redox potential was observed with time. The clay dredged material experienced a 39% reduction in water content and a 28% reduction soil salinity during the 5 months after filling. An increase in the redox potential for the clay substrate over 5 months was observed.

92. Table 21 depicted soil moisture, salinity and temperature at the beginning of the 1977 growing season for the experimental enclosures as well as a variety of *Spartina alterniflora* marsh types by height class adjacent to the study area. Each measurement was averaged over the 8 through 30 cm enclosure heights. The experimental enclosures soil salinity fell within the limits delineated by the various types of *Spartina alterniflora* marsh however, salinities

TABLE 20

PHYSICAL PROPERTIES OF THE THREE DREDGED MATERIALS USED IN THE MARSH SMOTHERING PROJECT

JULY 1976

DREDGED MATERIAL TYPE	DATE OF FILLING	REDOX POTENTIAL (mv)	SALINITY* 0/00	SALINITY† OF SOIL 0/00	% WATER
SAND	FEBRUARY	+380	3	17	6
SILTY SAND	FEBRUARY	+350	8	29	11
CLAY	FEBRUARY	+350	29	52	27
SAND	JULY	+480	5	27	4
SILTY SAND	JULY	+500	6	20	9
CLAY	JULY	+280	67	72	44

All values are averages of the six depth of fill. * A 1 part water: 1 part dry soil mixture. † Salinity of in situ soil calculated from the 1:1 mixture.

TABLE 21

MARSH SMOTHERING SOIL MOISTURE, SALINITY, AND TEMPERATURE

APRIL 1977

Location Description (control areas)	Soil Temperature °C (surface)	Moisture Content (percent)	Salinity (°/oo)
70 cm *Spartina alterniflora*	31.0	62.2	13
50 cm *Spartina alterniflora*	28.0	56.3	35
30 cm *Spartina alterniflora*	29.5	32.9	28
10-15 cm *Spartina alterniflora* & *Salicornia virginica*	35.0	27.6	54
Expermental Areas			
February filling:			
Sand	24.0	10.0	42
Sand and Clay	30.0	15.3	49
Clay	30.5	31.5	50
July Filling:			
Sand	31.0	10.5	36
Sand and Clay	29.0	14.0	35
Clay	30.0	37.2	20
November filling:			
Sand	30.0	14.2	48
Sand and Clay	32.0	16.2	36
Clay	26.0	45.7	47

tended to be higher in the experimental areas. It was important to monitor salinity levels since smaller height forms of *Spartina alterniflora* may evolve from the experimental enclosures with high soil salinities. This would affect comparisons of control and experiments areas by biomass or culm density estimates. With the exception of the clay dredged material, the soil moisture levels of the experimental enclosures was much lower than that of the surrounding marshes. This was the result of the higher elevation of the filled enclosures. The soil temperature was quite variable from area to area. The experimental enclosures had two areas with lower surface soil temperatures than the surrounding marshes. The similarity of soil temperatures for adjacent marsh and experimental enclosures suggested that soil temperature was not a factor altering *Spartina alterniflora* response. Soil salinity and temperature for the experimental enclosures fell within the limits of the adjacent *Spartina alterniflora* marshes suggesting there was no detrimental effect upon the surviving vegetation.

93. Available nitrogen and phosphorus in the three dredged materials changed with time after depostition (Table 22). Analyses performed in July 1976 for each of the dredged material types revealed decreased concentrations with time of all nutrients tested for the sand dredged material (February 1976) as compared to the more recent deposition in July 1976. The sand and clay substrate maintained consistent nitrogen levels from February to July 1976. The clay dredged material exhibited reduced concentrations of ammonia nitrogen and orthophosphate and an increase in nitrate and nitrate nitrogen concentrations. The December 1976 sampling period showed decreased nitrate and nitrite nitrogen and orthophosphate concentrations for all dredged material types deposited in February 1976 (Table 22). Ammonia concentrations increased for the two sandy dredged materials and decreased for the clay dredged material over the same interval. Increased ammonia concentrations indicated the initiation of microbial activity in the sandy materials. In December

TABLE 22

Available Nitrogen and Phosphorus of Three Types of Dredged Material Used in Marsh Smothering Enclosures

Sampling Date	Time of Deposition	Type of Dredged Material	Ammonia-N ppm	Nitrate & Nitrite-N ppm	Orthophosphate ppm
July 1976	February 1976	Sand	0.0	0.3	8.7
		Sand and Clay	0.0	0.1	22.3
		Clay	68.0	1.7	13.7
July 1976	July 1976	Sand	1.6	0.4	10.7
		Sand and Clay	0.0	0.1	17.3
		Clay	90.5	0.6	19.0
December 1976	February 1976	Sand	2.7	0.1	2.2
		Sand and Clay	5.2	0.0	5.9
		Clay	25.5	0.4	13.6
December 1976	July 1976	Sand	3.2	0.1	2.4
		Sand and Clay	8.1	0.1	8.7
		Clay	27.4	0.5	20.6
December 1976	November 1976	Sand	1.6	0.0	2.0
		Sand and Clay	3.7	0.0	5.0
		Clay	20.0	0.0	29.7
December 1976		Adjacent Marsh	22.0	0.1	3.4

All samples were taken from a depth of 0 - 3 cm.

1976 the three dredged materials deposited in July 1976 had slightly higher nutrient concentrations than their respective counterparts from the February 1976 filling. The December 1976 monitoring of the November 1976 filling yielded lower concentrations for the sandy dredged materials than either of the previous filling dates for the same materials. The November 1976 filling of the clay dredged material found lower levels of ammonia and higher levels of orthophosphate than was determined for the previous deposition dates.

94. Ammonia nitrogen concentrations in the clay dredged material remained similar to those recorded for adjacent marsh areas. Orthophosphate levels were higher in the clay material than for adjacent marsh areas. The sandy dredged materials had attenuated concentration of ammonia nitrogen, similar levels of nitrate and nitrite nitrogen and slightly higher levels of orthophosphate as compared to the adjacent marsh areas. Overall the clay dredged material contained the highest levels of all available nutrients, the sand and clay dredged material was second, and the sand dredged material was poorest in available nutrients. Generally orthophosphate levels in the dredged materials were in excess to those of the adjacent marsh.

95. In November 1977, composite soil samples representing three heights of filled enclosures were collected from each dredged material type to determine changes in the physical and chemcial properties of dredged materials with time (Tables 23 and 24). The cation exchange capacity increased for all dredged material types over the experimental period (Table 23). Cation exchange capacity values for the clay dredged material were similar to the control and adjacent marsh but the sandy dredged materials remained much lower than the control areas. Nitrate and nitrite nitrogen concentrations were lower for 8 through 23 cm sand dredged material, clay dredged material and the control enclosures than for the adjacent marsh. The 30 through 91 cm control areas yielded higher ammonia levels than the adjacent marsh. The remaining experimental enclosures had ammonia

TABLE 23

CHEMICAL ANALYSIS OF COMPOSITE CORES TAKEN IN THE MARSH SMOTHERING ENCLOSURES

NOVEMBER 1977

HEIGHT OF ENCLOSURES	SUBSTRATE TYPE	pH^W	% H_2O	CEC meg/100 g.	% O.M.	TOTAL N mg/g	NO_2 NO_3 µg/g	NH_3 µg/g	TOTAL P mg/g	PO_4 µg/g
8cm -23cm	sand	6.3	17	6.46	0.6	2.99	3.58	0.32	0.51	37.40
30cm -91cm	sand	6.2	3	3.84	0.3	1.52	25.68	0.36	0.16	104.40
8cm -23cm	sand & clay	5.8	19	6.98	0.8	2.03	30.05	0.43	0.12	693.60
30cm -91cm	sand & clay	6.1	8	9.16	0.3	33.77	28.51	2.26	1.05	644.10
8cm -23cm	clay	6.1	48	90.75	10.8	3.98	12.50	0.18	0.30	568.20
30cm -91cm	clay	5.8	30	59.61	7.8	3.45	3.13	0.16	0.24	644.70
8cm -23cm	control	6.2	47	87.84	8.3	5.90	9.52	0.26	1.02	722.90
30cm -91cm	control	5.5	58	115.00	12.0	12.80	8.54	5.31	1.35	710.68
	adjacent marsh	5.9	54	82.51	11.3	11.90	24.07	0.37	2.83	864.64

Height of enclosures= number of cm. above marsh surface; Substrate type= description of dredged materials used; pH^W= pH of 1:1 distilled water to soil mixture; % water= percent water content; CEC meg/100g.= Cation Exchange Capacity in milliequivalents per 100g dry weight of soil; % O.M.= Percent organic matter by weight; Total N mg/g= Total Kjeldahl Nitrogen in milligram per gram dry weight of soil; NO_3 NO_2 µg/g= Nitrate and Nitrite Nitrogen in micrograms per gram dry weight of soil; NH_3 µg/g= Ammonia-nitrogen in micrograms per gram dry weight of soil; TOTAL P mg/g= Total phosphorous in milligrams per gram dry weight soil; PO_4 µg/g= Orthophosphate in micrograms per gram dry weight of soil.

TABLE 24

MINERAL CONTENT OF COMPOSITE CORES TAKEN IN THE MARSH SMOTHERING ENCLOSURES

NOVEMBER 1977

HEIGHT OF ENCLOSURES	SUBSTRATE TYPE	Fe ppm	Cu ppm	P ppm	K ppm	Ca ppm	Mg ppm	Mn ppm	B ppm	S ppm	Co ppm	As ppm
8cm -23cm	sand	72.5	0.09	10.0	70.5	146.5	146.5	8.5	0.935	35.5	<5	0.33
30cm -91cm	sand	31.0	0.08	6.0	31.5	83.0	52.5	23.5	0.075	10.5	<5	0.56
8cm -23cm	sand & clay	127.5	0.80	20.0	110.0	241.5	195.5	31.5	0.525	71.5	<5	0.30
30cm -91cm	sand & clay	60.0	1.35	24.0	23.0	85.0	55.5	3.5	0.125	17.0	<5	0.11
8cm -23cm	clay	275.0	0.25	0.5	652.5	5125.0	1537.5	58.5	7.150	1315.0	10	4.87
30cm -91cm	clay	42.5	1.60	12.0	305.0	5100.0	605.0	47.5	2.980	2387.0	8	5.04
8cm -23cm	control	762.5	0.40	172.0	637.5	2737.5	1562.5	17.0	8.220	IA	8	4.61
30cm -91cm	control	825.0	0.20	112.0	565.0	565.0	1312.5	22.5	6.850	IA	10	5.56
	adjacent marsh	1125.0	0.50	40.0	40.0	842.5	2425.0	27.5	8.580	IA	10	5.57

Fe ppm= Iron mg/l; Cu ppm= Copper mg/l; P ppm= Phosphorus mg/l; K ppm= Potassium mg/l; Ca ppm= Calcium mg/l; Mg ppm= Magnesium mg/l; Mn ppm= Manganese mg/l; B ppm= Boron mg/l; S ppm= Sulfur mg/l; Co ppm= Cobalt mg/l; As ppm= Arsenic mg/l.

concentrations near those of the adjacent marsh. Orthophosphate concentrations were similar to the adjacent marsh for all dredged material types and control areas except for the sand dredged material which had much lower concentrations. Total nitrogen and phosphorus concentrations were generally lower for the experimental areas as compared to the adjacent *Spartina alterniflora* marsh.

96. Table 24 depicts mineral nutrient concentrations of the experimental and control areas. The control enclosures had iron concentrations less than the adjacent marsh and the filled dredged materials revealed much lower iron concentrations than the adjacent marsh. Iron concentrations in the experimental enclosures were higher for 8 through 23 cm enclosures than for the 30 through 91 cm enclosures. Potassium, magnesium and manganese concentration levels increased in all dredged materials over the interval of February 1976 to November 1977. Each of the dredged materials exhibited an increased total sulfur concentration from the February 1976 monitoring with the clay dredged material having a 1000 fold increase. Oxidation of the clay dredged material may have initiated chemical transformations associated with cat-clay formation and account for the increased sulfur levels.

97. Nutrients levels increased for each dredged material faster in the 8 through 23 cm enclosures than for the 30 through 91 cm enclosures. This was the result of more frequent tidal inundation of the shallower enclosures. Silt and organic particle accumulation and growth of a microbial community fostered the more rapid increase in nutrient levels within the inundated areas. Although each dredged material made significant increases in nutrient levels, the concentrations remained less than the surrounding *Spartina alterniflora* marsh soil. The clay dredged material continued to resemble the adjacent marsh soil in chemical and nutrient composition.

98. Initially the clay dredged material was the only dredged material type to possess nutrient levels comparable to adjacent

marsh areas. Low available nitrogen and phosphorus levels in the sandy dredged materials increased from 1976 to 1977. Until 1977 the nitrogen concentrations (ammonia and nitrate-nitrite) were lower and phosphorus concentrations (Orthophosphate) were higher in the sandy dredged materials than in adjacent marsh controls. The sand dredged material exhibited the least improvement in soil nutrient concentrations of the three dredged materials. Soil salinity was higher in experimental enclosures than in adjacent marsh areas. However the salinity levels were within the limits determined for a number of adjacent *Spartina alterniflora* marsh types. The low nutrient concentrations and higher salinity levels of the experimental enclosures were not evident when considering culm densities and biomass production from Part IV. A production advantage was noted for the clay dredged material which may be related to a more normal soil nutrient environment.

PART VI: PLANT INVASION OF EXPERIMENTAL ENCLOSURES

99. During regular monthly sampling periods any plant species other than *Spartina alterniflora* were recorded to document volunteer species. The various elevational regimes represented by the different depths of dredged material as well as the differences in physical properties of the dredged materials attracted a variety of marsh, transition, and upland species. Changes in the physical properties of the soil (Part V) in terms of salinity and pH also contributed to the diversification of habitat for attracting new species. Invading species propogation and dispersion was accomplished via windborne seeds, seeds desposited via the fecal material of birds, via waterborne seeds and via seeds deposited with the dredged material.

100. The higher elevation of the filled enclosures appeared to be the single most important factor in the survival of the invading species (Figure 28). Table 25 depicts the *cumulative* species composition list for the marsh smothering area. The code numbers in the invading species two-way frequency tables (Appendix D) corresponded to the species from Table 25 which occurred in the marsh smothering enclosures. Data collected over the entire two year period was pooled for the analysis. Since no invasion occurred in the control enclosures, they were not included in the analysis.

Invading Plant Species by Enclosure Height

101. The table of invading frequency (Appendix D) segmented the invading population by enclosure height. The most numerous invading species and the percent of experimental enclosures inhabited were as follows: *Baccharis halimifolia* (2.1%), *Phytolacca americana* (1.0%), *Digitaria sanguinalis* (0.9%), *Solidago sempervirens* (0.9%), *Salicornia virginica* (0.6%), and *Cynodon dactylon* (0.5%). Percent invasion pressure by filling depth was 8 cm (0.6%), 15 cm (1.2%),

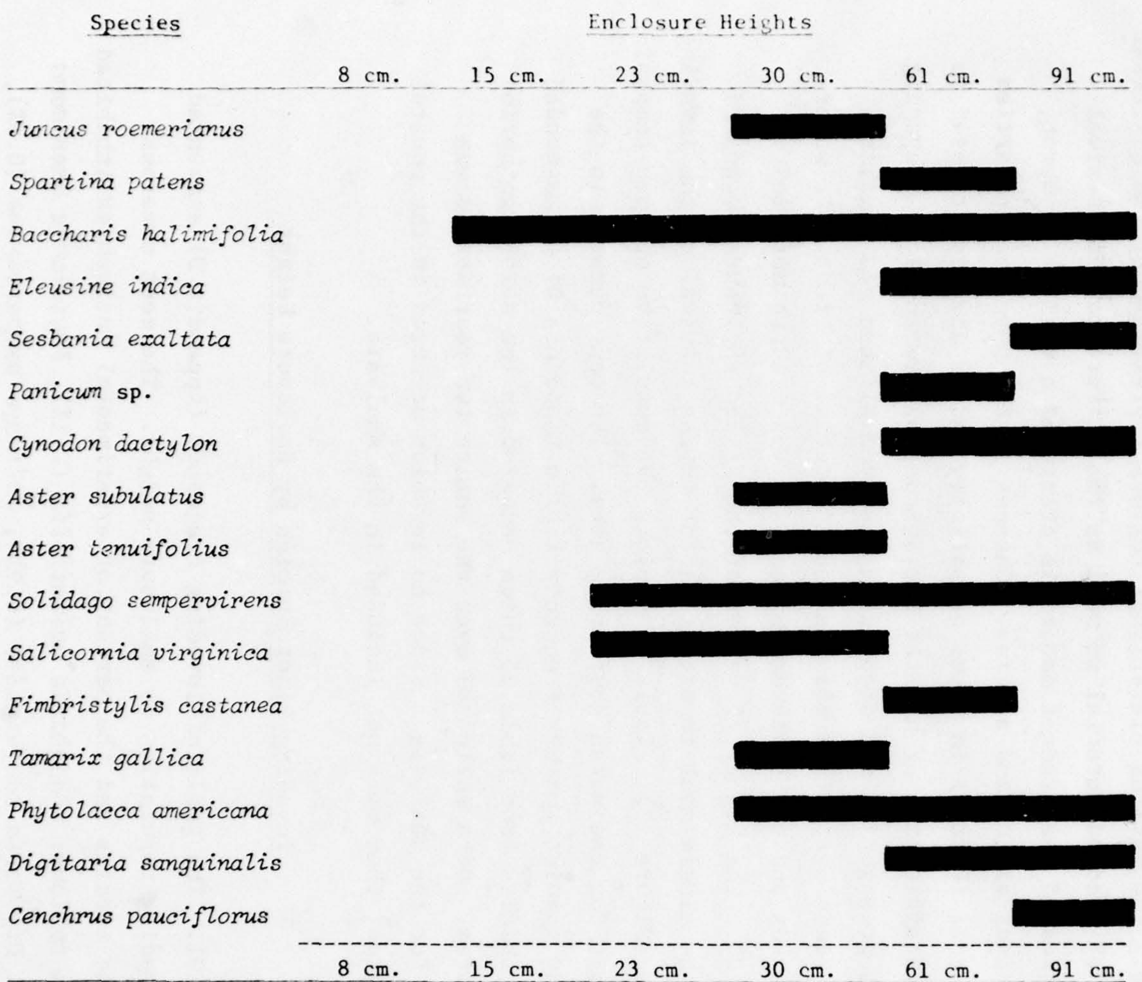


Figure 28. Occurance of invading plant species within Marsh Smothering experimental enclosures.

Table 25

Cumulative Species Composition List for Marsh

Smothering Experimental Enclosures

November 1976 - November 1977

Code Number	Scientific Names	Common Name
01	Unknown Species (Indicates Invader Was Present)	
05	*Juncus roemerianus* Scheel	Rush
08	*Spartina patens* (Ait.) Muhl.	Salt-Meadow
10	*Baccharis halimifolia* L.	Sea-Myrtle
13	*Eleusine indica* (L.) Gaern.	Goose-Grass
24	*Sesbania exaltata* (Raf.) Cory	Coffee-Bean weed
25	*Panicum* sp. L.	Panic Grass
26	*Cynodon dactylon* (L.) Pers.	Bermuda Grass
28	*Aster subulatus* Michx.	Aster
29	*Aster tenuifolius* L.	Aster
30	*Solidago sempervirens* L.	Seaside Goldenrod
31	*Salicornia virginica* L.	Perennial Saltwort
32	*Fimbristylis castanea* (Michx.) Vahl	Salt-Marsh Sedge
33	*Tamarix gallica* L.	Tamarisk
34	*Phytolacca americana* L.	Pokeweed
35	*Digitaria sanguinalis* (L.) Scop.	Crab-Grass
36	*Cenchrus pauciflorus* Benth.	Field Sand Bur

Code Number: Species number used for two way tables of invading species in Appendix D

Fernald, M. L., Gray's Manual of Botany, 8th ed., Nostrand, New York, 1970

23 cm (6.3%), 30 cm (20.4%), 61 cm (16.6%), and 91 cm (16.5%). Volunteer species in the 8 and 15 cm fills were nearly absent. This, no doubt, was the result of the filled elevation being within the limits of the *Spartina alterniflora* marsh and normal tidal inundation. The few species that appeared (*Baccharis halimifolia*) occurred soon after the filling operation when *Spartina alterniflora* densities were minimal.

102. The 23 cm enclosures were inhabited by *Salicornia virginica*, *Solidago sempervirens*, and *Baccharis halimifolia*, all of which were associated with salt marsh systems of the area. The low species diversity of invading species in these areas was the result of occasional tidal inundation and sufficient *Spartina alterniflora* recovery. The 30 cm enclosures contained the three volunteer species found in the 23 cm areas in addition to *Juncus roemerianus*, *Aster subulatus*, *Aster tenuifolius*, *Tamarix gallica*, and *Phytolacca americana*. The species composition for this height contained both marsh and upland species. Infrequent tidal inundation and depressed *Spartina alterniflora* densities provided more favorable habitat for upland type vegetation.

103. The 61 cm enclosures began to lose the marsh-type species associated with the shallower fill depths. *Juncus roemerianus*, *Aster subulatus*, *Aster tenuifolius*, and *Salicornia virginica* were all absent from the 61-cm enclosures with *Spartina patens*, *Eleusine indica*, *Panicum* sp., *Cynodon dactylon*, *Fimbristylis castanea*, and *Digitaria sanguinalis* all newcomers to the higher elevation. In terms of density, the grass species dominated the vegetation of the 61 cm enclosures. The 61 cm enclosures were rarely inundated by tidal water and were dependent upon rainfall for moisture input. The enclosures isolated and elevated the filled substrate from normal ground water influence, thus, creating a fast draining system leaving the surface much drier than a comparable elevation on the upland. Therefore, vegetation tolerant of poor soils and arid conditions would be expected to survive in these areas. The physical properties

of the substrate were the limiting factors which determined the species composition of the 61 cm enclosures.

104. The 91 cm enclosures had two additional plant species not yet encountered in other enclosures, *Sesbania exaltata* and *Cenchrus pauciflorus*. Those species occupying the 61 enclosures were also found in the 91 cm enclosure with the exception of *Spartina patens*, *Panicum* sp. and *Fimbristylis castanea*, all of which were infrequent species. The arid soil conditions described for the 61 cm enclosures was also prevalent at the 91 cm enclosures. The pokeweed, *Phytolacca americana*, was abundant in a number of the 91 cm enclosures. Several species of birds had many times been observed perched on the 91 cm enclosures, thus, the numerous pokeweed probably were seeded by deposition in the fecal material of the birds.

105. Analysis of the invading species by height classes gave some indication of the elevational regime created by the filling operation. Many of the plant species observed were characteristic of manipulated or otherwise poor soils. The invaders provided some indication of the type of vegetation which could be expected following a similar smothering operation and the number of species as well as the paucity of *Spartina alterniflora* suggested the eventual elimination of *Spartina alterniflora* from several elevational regimes.

Invading Plant Species by Dredged Material Type

106. The second set of two-way frequency tables found in Appendix D considered species by dredged material type. Overall plant invasion pressure for each dredged material type was clay (48%), sand (22%), and sand and clay (30%). The higher frequency of invasion for the clay dredged material resulted from its greater water retention and higher nutrient levels. *Baccharis halimifolia* preferred the clay dredged material (80.5%) over the sand dredged material (2.4%) or the sand and clay dredged material (17.1%). *Cynodon dactylon* and *Eleusine*

indica were more abundant in the sand dredged material with 66.7% and 50%, respectively, of the invading population occupying these enclosures. *Aster subulatus, Aster tenuifolius, Solidago sempervirens, Salicornia virginica* and *Fimbristylis castanae* all occurred 100% of the time within enclosures containing clay dredged material. The two *Asters* and *Fimbristylis castanea* had low frequencies of occurrence suggesting the trend manifest by these species may just be chance and not a real selection pressure for the clay substrate. *Tamarix gallica* and *Cenchrus pauciflorus* occupied only enclosures containing the sand dredged material. Again, low numbers suggested caution in formulating a concrete association. *Digitaria sanguinalis* preferred the sand dredged material (47%), with the sand and clay (29%), and clay (24%) dredged materials having nearly equal populations of the grass. The only species to be most abundant in the sand and clay dredged material was *Phytolacca americana*. A small portion of the pokeweed population occurred with the clay dredged material (5%) but the majority (95%) of the individuals occurred with the sand and clay dredged material. Species having low frequencies of occurrence were not discussed since the relationships described were more than likely due to chance.

Invading Plant Species by Month of Smothering

107. Appendix D. depicts the test for frequency differences between filling months. The February filling enclosures contained the highest frequency of invaders (54%), with the July filling (24%) and the November filling (22%) having about half of the remaining invasion pressure. Species preference by month followed nearly the same pattern set forth by the overall invasion pressure. *Baccharis halimifolia* steadily decreased in invasion pressure from February (59%), to July (27%), to November (15%). *Phytolacca americana* was the only species exhibiting a higher frequency of occurrence in November filled enclosures (85%) than either February (5%) or July (10%). *Spartina*

patens, Baccharis halimifolia, Eleusine indica, Panicum sp., *Salicornia virginica* and *Phytolacca americana* were the only species to inhabit the November filled enclosures. The evidence suggested the frequency of invasion and species diversity to be directly related to the length of time available for invasion to take place. Another factor influencing the greater plant invasion with time was the substrate consolidation and in some cases the development of a silt layer and associated microbial activity which would serve as a more favorable medium for attracting and retaining volunteer seeds.

Summary

108. The invasion pressure over all was minimal with 88.4% of the experimental enclosures lacking invasion. Several explanations of this lack of invading pressure were: 1) the small size of the enclosures reduced the surface area available to trap seeds; 2) the sandy dredged substrates lacked cohesive and adhesive properties necessary to retain and propagate volunteer seeds; 3) the experimental enclosures were located about 1.5 km from the upland, except for the road bed, and surrounded by salt marshes, therefore, the lack of a sufficient seed source may have been a factor. The necessity of dredged material to accumulate a silt layer, develop better quality soil characteristics (cation exchange capacity) and initiate a microbial community was demonstrated by the Buttermilk Sound Marsh Habitat Development project (Reimold et al. 1978) when significant invasion did not occur until the third growing season after the manipulation of the dredged material. Selection of the elevational regime best suited for survival of each invader was accomplished by segmenting the experimental enclosures by height (elevation above marsh level) and noting the species composition of each level. Marshland versus upland plants were distinguished by enclosure height. The clay dredged material was the most acceptable substrate for invading

species. Although the sandy dredged materials lacked heavy invasion pressure, they were more successful in attracting grasses adapted to arid and poor soil conditions than the clay dredged material. The month of filling illustrated an increase in invasion pressure with time. The time factor was again related to the development of a vegetative cover and to the development of better physical and chemical soil characteristics in the deposited dredged material. Consideration of the quantity and quality of the neighboring seed source was necessary to substantiate the degree of invasion pressure.

PART VII: COMPREHENSIVE SUMMARY

Culm Density

109. The effect of the depth of dredged material placed over a marsh was the primary determinator of the degree of marsh recovery as measured by culm density. Each successive increment in depth of dredged material yielded a significantly lower mean culm density. The 61 and 91 cm enclosures yielded essentially no recovery from the smothering operation. Initial recovery was segmented according to depth of dredged material, however, by November 1977 culm densities in the 8, 15 and 23 cm enclosures were similar. The 30 cm enclosures retained somewhat attenuated culm densities in November 1977. The effect of month of deposition produced highest culm densities for the February filling. The month of deposition resulted in different recovery intervals for each filling month and may have been more of a factor in the density differences than the treatment itself. The treatment of dredged material type showed sand and clay dredged material to have the greatest culm density. The smothering operation using the clay dredged material reduced culm densities in each height enclosure more than the sandy dredged materials. The physical nature of the dredged material controlled initial culm densities following smothering. The actual differences between culm density means for each of the dredged material types was small suggesting a longer recovery period may negate any differences.

Live Crabs and Crab Burrows

110. Crab burrow density and live crab density both documented enclosure height and soil as the significant treatments controlling fiddler and squareback crab populations. Initially, the inability of the crabs to maintain burrows in the sandy dredged materials limited

their distribution. As the surface consistancy of these dredged materials was changed by the accumulation of silt and clay particles, the crab populations were able to recolonize the areas. The similarity of the clay dredged material to the underlying marsh resulted in signigicantly higher crab burrow and live crab densities at all enclosure heights for the clay dredged material. The initial population of *Uca pugnax* crabs was replaced by *Uca pugilator* and *Sesarma reticulatum* in the two sandy dredged materials. Crab burrow density varied inversely to enclosure height, much the same as culm density. Crab burrow densities in 8, 15 and 23 cm enclosures were significantly higher than the taller enclosures and live crab densities were significantly higher in 8 cm enclosures. Live crab and crab burrow densities failed to describe any significant differences to month of smothering.

Marsh Snails

111. The two marsh snails exhibited similar significance to the treatment interactions, namely: enclosures height, month, and enclosure height x month. Culm density was significant for the same treatment interactions suggesting the dependence of both species of snails upon the presence of sufficient vegetation to provide habitat for their survival. *Littorina irrorata* and *Melampus bidentatus* densities were significantly greater in 8 and 15 cm enclosures. Dredged material type was a significant factor in determining crab burrow density but failed to produce any significant differences for either snail population. This illustrated different environmental factors to be controlling snail populations than were controlling crab populations. Lower overall mean density for both species of snail in the experimental as well as control areas in 1977 indicated factors other than the experimental treatments to account for the decrease.

Control Areas

112. A comparison of the three control types revealed both the enclosure controls of 30 cm or less and the 3m x 3m enclosure controls to have slightly higher culm densities than the adjacent marsh controls. This may be an indication of a container effect causing the higher density of *Spartina alterniflora* culms. Enclosure controls of 61 and 91 cm exhibited attenuated culm densities probably due to the restriction of incident sunlight. The adjacent marsh control areas yielded higher densities of live crabs, crab burrows and *Littorina irrorata* than either type of enclosure controls. The 3m x 3m enclosure control had higher densities of *Melampus bidentatus* than either the adjacent marsh or the enclosure controls. The restrictive nature of the enclosure walls was least evident for the *Spartina alterniflora* culm density and most evident in the mobile populations of crabs and snails.

Spartina alterniflora Biomass

113. The estimated biomass measurements for the experimental and control enclosures revealed differences in biomass were related to smothering depth, dredged material type and month of smothering. The largest mean biomass differences resulted from the depth of smothering. Immediately after smothering, the number of culms and rhizomes able to grow through the dredged material was small. The two sandy dredged materials allowed a higher density of culms to emerge than did the clay dredged material. This density trend continued, however, in terms of biomass the clay dredged material produced higher combined live and dead biomass than did either of the sandy dredged materials. The more luxuriant growth of *Spartina alterniflora* in the clay dredged material probably was the result of added nutrients from the dredged material. The gradation of

biomass production versus depth of dredged material showed 8, 15 and 23 cm enclosure heights to have highest biomass production. The overall estimated biomass production for the 8, 15 and 23 cm enclosures in November 1977 was 11% less than the enclosure controls and 46% less than adjacent marsh areas. The similarity of the experimental and control enclosure biomass values indicated the filled enclosures were approaching full recovery within experimental restraints. The 30 cm enclosures produced significantly less biomass than the 8, 15 and 23 cm enclosures and the 61 and 91 cm enclosure biomass values were the result of naturally seeded *Spartina alterniflora* and therefore not a true indicator of recovery from a smothering operation.

114. Biomass differences related to dredged material type described the clay dredged material to have the highest biomass production with the two sandy dredged materials not far behind. The sand dredged material and the clay dredged material yielded similar biomass values for dead material with the sand and clay material producing slightly less dead biomass.

115. The July filling period yielded significantly less combined biomass than either the February or November filling months. Lower dead biomass values for the July filling indicated the lower overall biomass resulted from less growth the previous year since the standing dead would be an indicator of the previous year's growth.

116. Overall biomass increases from April 1977 to November 1977 resulted from substantial increases in the 23 and 30 cm enclosures. The 8 and 15 cm enclosures for all dredged materials maintained lower biomass values than the enclosures controls and adjacent marsh controls. By November 1977, the 8, 15, 23 and 30 enclosures contained similar biomass values; however, levels were still lower than control areas.

117. A comparison of adjacent marsh and enclosure control areas revealed the enclosure controls to have an attenuated mean biomass from that of the adjacent marsh areas. In April 1977 the two control types were similar, but in November 1977 the control

enclosures lacked the recruitment (culm density) and biomass levels of the adjacent *Spartina alterniflora* marsh. The disparity between the two control types indicated a possible container effect was beginning in the enclosures. Restriction of tidal inundation, interstitial water movement or incident sunlight were factors associated with the enclosures which may have attributed to the attenuated culm density and biomass in the enclosure controls. The filled enclosures of 8 and 15 cm approximated the biomass and density values of the enclosure controls suggesting the filled enclosures had attained full recovery within the experimental restraints of the enclosures. Biomass estimates using the regression equations for the adjacent marsh were 33 percent higher than estimates by destructive techniques.

Dredged Material Chemistry

118. Initially the clay dredged material was the only dredged material type to possess nutrient levels comparable to adjacent marsh areas. Low available nitrogen and phosphorus levels in the sandy dredged materials increased from 1976 to 1977. Until 1977 the nitrogen concentrations (ammonia and nitrate-nitrite) were lower and phosphorus concentrations (orthophosphate) were higher in the sandy dredged materials than in adjacent marsh controls. The sand dredged material exhibited the least improvement in soil nutrient concentrations of the three dredged materials. Soil salinity was higher in experimental enclosures than in adjacent marsh areas. However, the salinity levels were within the limits determined for a number of adjacent *Spartina alterniflora* marsh types. The low nutrient concentrations and higher salinity levels of the experimental enclosures were not evident when considering culm densities and biomass production from Part IV. A slight production advantage was noted for the clay dredged material which may be related to a more normal soil nutrient environment.

119. Nutrients levels increased for each dredged material faster in the 8 through 23 cm enclosures than for the 30 through 91 cm enclosures. Silt and organic particle accumulation and growth of a microbial community fostered the more rapid increase in nutrient levels within the inundated areas. Although each dredged material made significant increases in nutrient levels, the concentrations remained less than the surrounding *Spartina alterniflora* marsh soil.

Invading Plant Species

120. The invasion pressure over all was minimal with 88.4% of the experimental enclosures lacking invasion. Several explanations of this lack of invading pressures were: 1) the small size of the enclosures reduced the surface areas available to trap seeds; 2) the sandy dredged substrates lacked cohesive and adhesive properties necessary to retain and propagate volunteer seeds; 3) the experimental enclosures were located nearly a mile from the upland, except for the road bed, and surrounded by salt marshes, therefore, the lack of a sufficient seed source may have been a factor. The necessity for dredged material to accumulate a silty layer, develop better quality soil characteristics (cation exchange capacity) and initiate a microbial community was demonstrated by the Buttermilk Sound Marsh Habitat Development project (Reimold et al. 1978) when significant invasion did not occur until the third growing season after the manipulation of the dredged material. Selection of the elevational regime best suited for survival of each invader was accomplished by segmenting the experimental enclosures by height (elevation above marsh level) and noting the species composition of each level. Marshland versus upland plants were distinguished by enclosure height. The clay dredged material was the most acceptable substrate for invading species. Although the sandy dredged materials lacked heavy invasion pressure, they were more successful in attracting grasses adapted to arid and poor soil conditions than

the clay dredged material. The month of filling illustrated an increase in invasion pressure with time. The time factor was again related to the development of a vegetative cover and to the development of better physical and chemical soil characteristics in the deposited dredged material. Consideration of the quantity and quality of the neighboring seed source was necessary to substantiate the degree of invasion pressure.

PART VIII: RECOMMENDATIONS

123. Table 26 provides a summary of the relative success of the plant, crab and snail populations at each of the treatment combinations. The relative scoring system indicates potential detrimental effects to each of the biotic populations imposed by the deposition of dredged material upon the marsh. This table might serve as a tool for management personnal to make objective decisions concerning the most economically feasible and enviromentally sound disposal method on *S. alterniflora* marshes.

124. Assessment of the fauna and flora at four week intervals since the establishment of the project revealed that dredged material placed on the surface of the marsh in a layer no thicker than 23 cm (9 inches) does not significantly impede the growth of the marsh plants. *S. alterniflora* was able to penetrate through the 8 cm (3 inches) 15 cm (6 inches), and 23 cm (9 inches) layers of all three types of dredged material. The plants exhibited biological growth and production nearly equal to that of *S. alterniflora* in the control, undisturbed marsh. Fiddler and squareback crab populations were able to survive smothering of 23 cm of dredged material. Crab survival was also a function of dredged material type in terms of burrowing capability and continued burrow integrity. The species of crabs present were dependent upon the texture of the dredged material. Snail populations were destroyed by a smothering operation however recolonization was rapid in 8 and 15 cm depths of dredged material. The return of marsh snails was dependent upon reestablishment of marsh habitat in terms of *S. alterniflora* recovery. Recovery from smothering operations may depend upon the proximity of the disposal area to natural crab and snail populations and the extent of the smothered area may dictate the time necessary for the return of macroinvertebrate populations.

125. The initial effects (through two years of monitoring) of the addition of thin layers of the clay dredged material resulted in an

Table 26 Summary of marsh plant, snail and crab recovery from different depths, times and types of dredged material deposited on a short *Spartina alterniflora* marsh.

unconsolidated depth of material	SAND			SILTY SAND			CLAY		
	Feb fill	July fill	Nov fill	Feb fill	July fill	Nov fill	Feb fill	July fill	Nov fill
8cm	PR= 4 SR= 4 CR= 3	PR= 4 SR= 3 CR= 3	PR= 4 SR= 2 CR= 3	PR= 4 SR= 4 CR= 3	PR= 4 SR= 4 CR= 3	PR= 4 SR= 2 CR= 3	PR= 4 SR= 4 CR= 4	PR= 4 SR= 3 CR= 4	PR= 4 SR= 2 CR= 4
15cm	PR= 4 SR= 4 CR= 2	PR= 4 SR= 3 CR= 2	PR= 4 SR= 1 CR= 2	PR= 4 SR= 4 CR= 2	PR= 4 SR= 2 CR= 2	PR= 4 SR= 2 CR= 2	PR= 4 SR= 4 CR= 4	PR= 4 SR= 2 CR= 4	PR= 4 SR= 1 CR= 3
23cm	PR= 4 SR= 2 CR= 1	PR= 4 SR= 2 CR= 1	PR= 4 SR= 1 CR= 1	PR= 4 SR= 2 CR= 1	PR= 4 SR= 1 CR= 1	PR= 4 SR= 1 CR= 1	PR= 4 SR= 2 CR= 3	PR= 4 SR= 2 CR= 4	PR= 4 SR= 1 CR= 4
30cm	PR= 3 SR= 0 CR= 1	PR= 3 SR= 1 CR= 1	PR= 2 SR= 1 CR= 1	PR= 3 SR= 2 CR= 1	PR= 2 SR= 1 CR= 1	PR= 3 SR= 1 CR= 1	PR= 3 SR= 2 CR= 2	PR= 2 SR= 1 CR= 2	PR= 2 SR= 1 CR= 2
61cm	PR= 0 SR= 0 CR= 0	PR= 0 SR= 0 CR= 0	PR= 1 SR= 0 CR= 0	PR= 0 SR= 0 CR= 1	PR= 0 SR= 0 CR= 0	PR= 1 SR= 0 CR= 1	PR= 1 SR= 0 CR= 0	PR= 0 SR= 0 CR= 0	PR= 1 SR= 0 CR= 0
91 cm	PR= 0 SR= 0 CR= 0	PR= 0 SR= 0 CR= 0	PR= 1 SR= 0 CR= 0	PR= 0 SR= 0 CR= 0	PR= 0 SR= 0 CR= 1	PR= 1 SR= 0 CR= 0	PR= 0 SR= 0 CR= 0	PR= 0 SR= 0 CR= 0	PR= 1 SR= 0 CR= 0

PR= plant recovery
SR= snail recovery
CR= crab recovery

4 = EXCELLENT
3 = GOOD
2 = AVERAGE
1 = POOR
0 = NO RECOVERY

increased growth in the plant population. It appears that the thin layer of dredged material containing additional nutrients was adequate to supply the small additional amount of nitrogen needed by many coastal wetland plants to show a response in the form of increased growth. By the termination of the two year monitoring period the plant growth was analogous to that of the sandy dredged materials indicating the eventual equality of all three dredged materials. One of the limiting factors in conducting such a disposal methodology as this would be to assure that the dredged materials were deposited in a uniform thickness layer on the surface of the marsh. The effect of season did not appear to have relevance to the outcome of the success of this means of disposal.

124. As indicated by the experimental plant response and the invading species occurance, the 8 through 23 cm filling depths were within the elevational range of the *S. alterniflora* marsh. Filling to a depth outside the normal marsh elevation would reduce or eliminate the ability of the underlying marsh to recover as seen by the 30 through 91 cm filling depths. Therefore, it is necessary to collect accurate tidal and elevational data for the marsh being smothered to assure the resultant elevation after the deposition of the dredged material is within the elevational limits of similar contiguous marshes.

125. The smothering of existant *S. alterniflora* high marsh with dredged material is a feasible disposal alternative but should only be employed when the feasibility of other disposal alternatives are economically or physically impossible. The assurance of a uniform layer of unconsolidated dredged material not to exceeded the elevational regime of existing *S. alterniflora* marshes is essential to the continued survival of the salt marsh. The effects of the smothering operation have been documented for *S. alterniflora*, fiddler crabs and marsh snail populations; however, effects upon microbial, other invertebrate and vertebrate populations have not been addressed. Until the effects upon all the biotic communites and the abiotic environment resulting from a smothering operation

have been determined, this dredged material disposal alternative should be used with caution. More research, including the actual smothering of a small marsh area is essential before this alternative can be declared ecologically sound.

REFERENCES

Armstorong, F. A., C. R. Sterns, and J. D. H. Strickland. 1967. The measurement of upwelling and subsequent biological processes by means of the techicon autoanalyzer and associated equipment. Deep-Sea Research 14: 381-389.

Barr, A. J., J. H. Goodnight, J. P. Sall, and J. T. Helwig. 1976. A user's guide to SAS 76, 5th Printing. Sparks Press. Raleigh, N. C. 329 pp.

Chapman, H. D. 1965. *Cation-exchange capacity.* *In:* C. A. Black (Ed.). Methods of Soils Analysis Part 2. Agronomy 9: 891-901.

Federal Water Pollution Control Administration. 1969. Methods for Chemical Analysis of Water and Wastes. 137 pp.

Gallagher, J. L., R. J. Reimold, R. A. Linthurst, and W. J. Pfeiffer. (In press). Aerial production, mortality, and mineral accumulation dynamics in *Spartina alterniflora* and *Juncus roemerianus* in a Georgia salt marsh. (Ecology).

Reimold, R. J., M. A. Hardisky, and P. C. Adams. 1978. Habitat development field investigations, Buttermilk Sound marsh development site, Atlantic Intracoastal Waterway, Georgia. Appendix A: Propagation of marsh plants and postpropagation monitoring. TR D-78-26. U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Issac, R. A. and J. B. Jones. 1971. AutoAnalyzer system for the analysis of soil and plant tissue extracts. In: Technicon International Congress 1970, Tarrytown, N. Y. pp. 57-64.

Issac, R. A. and J. D. Kerber. 1971. Atomic absorption and flame photometry: technique and uses in soil, plant, and water analysis. In: L. M. Walsh (Ed.) Instrumental Methods of Analysis of Soils and Plant Tissue. Soil Sci. Soc. Amer., Madison, Wis., pp. 17-37.

Jackson, M. L. 1958. Soil Chemical Analysis, Prentice-Hall, Inc., Englewood Cliffs, N. J. pp. 219-220

Jones, J. B. and R. A. Issac. 1972. Determination of sulfur in plant material using a leco sulfur analyzer. J. Agr. and Food Chem. 20 (6): 1292-1294.

Nelson, W. L., A. Mehlich, and E. Winters. 1953. The development, evaluation, and use of soil tests for phosphorus availability. In: W. H. Pierre and A. G. Norman (Eds.). Soil and Fertilizer Phosphorus. Agronomy, A Series of Monographs, Academic Press, Inc. N. Y. 2: 153-188.

Nixon, S. W. and C. A. Oviatt. 1973. Ecology of a New England salt marsh. Ecol. Monogr. 43(4): 463-498.

Pearsall, W. H. and C. H. Mortimer. 1939. Oxidation-reduction potentials in waterlogged soils, natural waters, and muds. J. Ecol. 27: 483-501.

Peech, M. 1965. Hydrogen-ion activity. In: C. A. Black (Ed.). Methods of Soil Analysis, Part 2. Chemical and Microbiological Properties #9, Amer. Soc. Agron, Madison, Wis. pp.914-925.

Perkins, H. F. 1970. A rapid method of evaluating the zine status of coastal plain soils, Comm. in Soil Sci. and Plant Anal. 1: 35-46.

Reimold, R. J. and M. A. Hardisky. Non-Destructive Estimation of Salt Marsh Plant Biomass. In Preparation.

Reimold, R. J. and R. A. Linthurst. 1977. Primary Productivity of Minor Marsh Plants in Delaware, Georgia, and Maine. Technical Report D-77-36. U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss. pp. 104.

Saunders, W. M. H. 1965. Phosphate retention by New Zealand soils and its relationship to free sesquioxides, organic matter, and other soil properties. New Zealand J. Agric. Res. 8: 30-57.

Technicon. 1973. Total inorganic phosphate in water and wastewater. Method #93-70W Technicon Industrial Systems, Tarrytown, New York.

Technicon. 1975. Digestion and sample preparation for the analysis of total Kjeldahl nitrogen. Method #376-75W. Technicon Industrial Systems, Tarrytown, New York.

Toth, S. J. and A. N. Ott. 1970. Characterization of bottom sediments: cation exchange capacity and exchangeable cation status. Environmental Science and Technology 4(11): 935-939.

Turner, R. E. and J. G. Gosselink. 1975. A note on standing crop of *Spartina alterniflora* in Texas and Florida. Contributions in Marine Science. 19: 113-118.

Williams, R. B., and M. B. Murdock. 1969. The potential importance of *Spartina alterniflora* in conveying zinc, manganese, and iron into estuarine food chains. Proceedings of the Second National Symposium on Radioecology. USAEC. CONF-670503. Ann Arbor Mich.

Van Slyke, D. D. and A. J. Hiller. 1933. The determination of ammonia in blood. Journal of Biological Chemistry. 102: 499-504.

Wolf, B. 1971. The determination of boron in soil extracts, plant materials, composts, manures, water, and nutrient solutions. Comm. Soil Sci. Plant Anal. 2 (5): 363-374.

Wolf, P. L., S. Shanholtzer, and R. J. Reimold. 1975. Population estimates of *Uca pugnax* (Smith, 1970) on the Duplin Estuary Marsh, Georgia. U.S.A. Crustaceana, 29 (1): 79-91.

US GOVERNMENT PRINTING OFFICE: 1978-740-235/16

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Reimold, Robert J

The effects of smothering a Spartina alterniflora salt marsh with dredged material / by Robert J. Reimold, Michael A. Hardisky, Patrick C. Adams, Marine Extension Service, University of Georgia, Brunswick, Ga. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.

ix, 114 p. : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; D-78-38)

Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C., uder Contract No. DACW21-75-C-0074 (DMRP Work Unit No. 2A07)

Appendices A-D on microfiche in pocket.

References: p. 112-114.

1. Dredged material. 2. Dredged material disposal. 3. Marsh development. 4. Salt marshes. 5. Vegetation establishment. I. Adams, Patrick C., joint author. II. Hardisky, Michael A., joint author. III. Georgia. University. Marine Extension Service. IV. United States. Army. Corps of Engineers. V. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Technical report ; D-78-38.

TA7.W34 no.D-78-38

DREDGED MATERIAL RESEARCH PROGRAM

TECHNICAL REPORT D-78-38

THE EFFECTS OF SMOTHERING A SPARTINA ALTERNIFLORA SALT MARSH WITH DREDGED MATERIAL

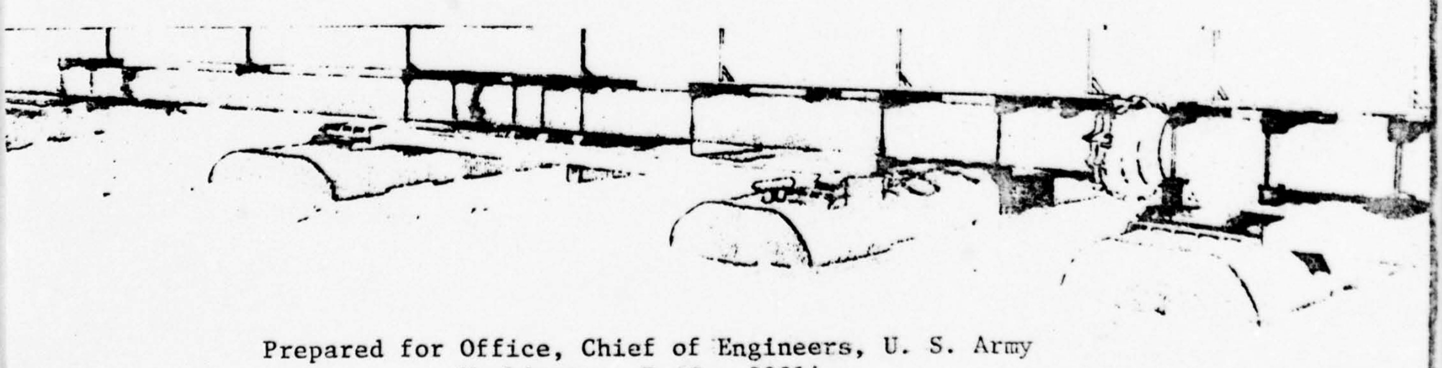
by

Robert J. Reimold, Michael A. Hardisky, Patrick C. Adams

Marine Extension Service
University of Georgia
Brunswick, Ga. 31520

July 1978

Final Report



Prepared for Office, Chief of Engineers, U. S. Army
Washington, D. C. 20314

Under Contract No. DACW21-75-C-0074
(DMRP Work Unit No. 2A07)

Monitored by Environmental Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

APPENDIX A

ANALYSIS OF VARIANCE FOR MARSH SMOTHERING ENCLOSURE AND CONTROL AREAS

Parts 1-3

Legend for Dependent Variable Codes

cul	=	Live culms /m^2
crab	=	Live crabs /m^2
bur	=	Crab burrows /m^2
lit	=	*Littorina irrorata* /m^2
mel	=	*Melampus bidentatus* /m^2
lit_log	=	Natural log of *L. irrorata* /m^2
mel_log	=	Natural log of *M. bidentatus* /m^2

Legend of Class Variable Codes

Height	=	Enclosure height
3	=	8 cm
6	=	15 cm
9	=	23 cm
12	=	30 cm
24	=	61 cm
36	=	91 cm
Soil	=	Dredged Material type
SA	=	Sand
SI	=	Sand and Clay
CL	=	Clay

Mon	=	Month of Deposition
F	=	February 1975
J	=	July 1976
O	=	November 1976

Part 2

Legend for Class Variable

Control

1	=	Control enclosures (0.656 m^2)
0	=	Experimental enclosures (0.656 m^2)

Part 3

Legend for Class Variable

Control 2

0	=	Experimental enclosures
1	=	Adjacent Marsh Control areas

Control 3

0	=	Experimental enclosures
1	=	3m x 3m Enclosure Contral areas

Control

0	=	Experimental enclosures
1	=	0.656 m^2 enclosure controls

PART 1

Analysis of Variance

General Linear Model

Dependent variables by height, soil and month for experimental enclosures

PART 2

Analysis of Variance

General Linear Model

Dependent variabler by height for experimental and control $0.656\ m^2$ enclosures

PART 3

Analysis of Variance

General Linear Model

Dependent variables of Experimental enclosures by control type.

PART 1

STATISTICAL ANALYSIS SYSTEM 13:02 THURSDAY, APRIL 20, 1978 1

GENERAL LINEAR MODELS PROCEDURE

CLASS LEVEL INFORMATION

CLASS	LEVELS	VALUES
HEIGHT	6	3 6 9 12 24 36
SOIL	3	CL SA SI
MON	3	F J O

NUMBER OF OBSERVATIONS IN DATA SET = 1728

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 20, 1978   2

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: CUL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	53	12829244.27719907	242061.21277734	107.22	0.0001	0.772453	43.6997
ERROR	1674	3779197.43055556	2257.58590396		STD DEV		CUL MEAN
CORRECTED TOTAL	1727	16608441.70775463			47.51405144		108.72858796

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	11958581.89178263	1059.41	0.0001	5	11189007.99922841	991.24	0.0001
SOIL	2	60332.07060185	13.36	0.0001	2	59541.66159612	13.19	0.0001
HEIGHT*SOIL	10	116362.58912037	5.15	0.0001	10	101692.97729277	4.50	0.0001
MON	2	233229.14834105	51.65	0.0001	2	233229.14834105	51.65	0.0001
HEIGHT*MON	10	292012.93152006	12.93	0.0001	10	292012.93152006	12.93	0.0001
SOIL*MON	4	32779.97723765	3.63	0.0059	4	32779.97723765	3.63	0.0059
HEIGHT*SOIL*MON	20	135945.66859568	3.01	0.0001	20	135945.66859568	3.01	0.0001

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: CRAB

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	53	3981.03240741	75.11381901	4.31	0.0001	0.120122	568.7800
ERROR	1674	29160.51388889	17.41966182		STD DEV		CRAB MEAN
CORRECTED TOTAL	1727	33141.54629630			4.17368694		0.73379630

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	2015.51157407	23.14	0.0001	5	2053.40002205	23.58	0.0001
SOIL	2	579.02893519	16.62	0.0001	2	580.61529482	16.67	0.0001
HEIGHT*SOIL	10	1126.15162037	6.46	0.0001	10	1152.75507055	6.62	0.0001
MON	2	12.74151235	0.37	0.6938	2	12.74151235	0.37	0.6938
HEIGHT*MON	10	58.20524691	0.33	0.9721	10	58.20524691	0.33	0.9721
SOIL*MON	4	32.50038580	0.47	0.7604	4	32.50038580	0.47	0.7604
HEIGHT*SOIL*MON	20	156.89313272	0.45	0.9825	20	156.89313272	0.45	0.9825

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SUR

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	53	322709.86574074	6088.86539133	24.42	0.0001	0.436041	223.2127
ERROR	1674	417380.65277778	249.33133380		STD DEV		SUR MEAN
CORRECTED TOTAL	1727	740090.51851852			15.79022906		7.07407407

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	121341.42129630	97.33	0.0001	5	119972.97806437	96.24	0.0001
SOIL	2	86909.85185185	174.09	0.0001	2	83189.89043210	166.83	0.0001
HEIGHT*SOIL	10	98175.82870370	39.38	0.0001	10	97261.76300705	39.01	0.0001
MON	2	339.88040123	0.68	0.5060	2	339.88040123	0.68	0.5060
HEIGHT*MON	10	4180.95293210	1.68	0.0807	10	4180.95293210	1.68	0.0807
SOIL*MON	4	419.29783951	0.42	0.7940	4	419.29783951	0.42	0.7940
HEIGHT*SOIL*MON	20	11442.63271605	2.29	0.0009	20	11442.63271605	2.29	0.0009

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LIT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	53	20.41666667	0.38522013	2.36	0.0001	0.069622	645.9382
ERROR	1674	272.83333333	0.16298288		STD DEV		LIT MEAN
CORRECTED TOTAL	1727	293.25000000			0.40371139		0.06250000

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	5.92361111	7.27	0.0001	5	5.54497354	6.80	0.0001
SOIL	2	0.26388889	0.81	0.4452	2	0.36309524	1.11	0.3285
HEIGHT*SOIL	10	1.08333333	0.66	0.7581	10	0.71494709	0.44	0.9280
MON	2	2.11419753	6.49	0.0016	2	2.11419753	6.49	0.0016
HEIGHT*MON	10	6.12885802	3.76	0.0001	10	6.12885802	3.76	0.0001
SOIL*MON	4	0.60802469	0.93	0.4440	4	0.60802469	0.93	0.4440
HEIGHT*SOIL*MON	20	4.29475309	1.32	0.1566	20	4.29475309	1.32	0.1566

STATISTICAL ANALYSIS SYSTEM 13:02 THURSDAY, APRIL 20, 1978 6

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: REL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	53	8337.17997685	157.30528258	5.09	0.0001	0.138883	392.0966
ERROR	1674	51692.98611111	30.87992002		STD DEV		REL MEAN
CORRECTED TOTAL	1727	60030.16608796			5.55697046		1.41724537

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	5177.10706019	33.53	0.0001	5	4140.58564815	26.82	0.0001
SOIL	2	14.93171296	0.24	0.7853	2	9.66071429	0.16	0.8552
HEIGHT*SOIL	10	38.07523148	0.12	0.9996	10	23.00462963	0.07	1.0000
MON	2	1013.86593364	16.42	0.0001	2	1013.86593364	16.42	0.0001
HEIGHT*MON	10	1707.66068673	5.53	0.0001	10	1707.66068673	5.53	0.0001
SOIL*MON	4	78.51427469	0.64	0.6371	4	78.51427469	0.64	0.6371
HEIGHT*SOIL*MON	20	307.02507716	0.50	0.9688	20	307.02507716	0.50	0.9688

STATISTICAL ANALYSIS SYSTEM 13:02 THURSDAY, APRIL 20, 1978 7

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LIT_LOG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	53	5.04529931	0.09519433	2.65	0.0001	0.077397	613.2092
ERROR	1674	60.14216082	0.03592722		STD DEV		LIT_LOG MEAN
CORRECTED TOTAL	1727	65.18746014			0.18954476		0.03091029

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	1.57428770	8.76	0.0001	5	1.40444106	7.82	0.0001
SOIL	2	0.03099717	0.43	0.6497	2	0.04459231	0.62	0.5377
HEIGHT*SOIL	10	0.29234485	0.81	0.6155	10	0.19136005	0.53	0.8680
ROW	2	0.61491623	8.56	0.0002	2	0.61491623	8.56	0.0002
HEIGHT*ROW	10	1.46661987	4.08	0.0001	10	1.46661987	4.08	0.0001
SOIL*ROW	4	0.13356393	0.93	0.4458	4	0.13356393	0.93	0.4458
HEIGHT*SOIL*ROW	20	0.93256952	1.30	0.1693	20	0.93256952	1.30	0.1693

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 20, 1978   8

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: MEL_LOG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	53	250.57948194	4.72791475	10.64	0.0001	0.251987	239.1780
ERROR	1674	743.83316447	0.44434471		STD DEV		MEL_LOG MEAN
CORRECTED TOTAL	1727	994.41264641			0.66659192		0.27870119

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	153.83059892	69.24	0.0001	5	126.53736613	56.95	0.0001
SOIL	2	0.35331057	0.40	0.6720	2	0.30187946	0.34	0.7120
HEIGHT*SOIL	10	2.46135129	0.55	0.8486	10	2.17568071	0.49	0.8977
MON	2	34.30382415	38.60	0.0001	2	34.30382415	38.60	0.0001
HEIGHT*MON	10	53.10040537	11.95	0.0001	10	53.10040537	11.95	0.0001
SOIL*MON	4	1.17223395	0.66	0.6202	4	1.17223395	0.66	0.6202
HEIGHT*SOIL*MON	20	5.33775768	0.60	0.9149	20	5.33775768	0.60	0.9149

STATISTICAL ANALYSIS SYSTEM   13:02 THURSDAY, APRIL 21, 1977   9

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE COL

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=2257.59

GROUPING	MEAN	N	HEIGHT
A	217.847222	288	3
B	184.777778	288	6
C	148.975694	288	9
D	92.777778	288	12
E	7.208333	288	24
E			
E	0.784722	288	36

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:0? THURSDAY, APRIL 20, 1976   10

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE CRAH

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=17.4147

GROUPING	MEAN	N	HEIGHT
A	3.072917	288	3
[illegible]	0.739583	288	6
[illegible]	0.479167	288	9
[illegible]	0.097222	288	12
[illegible]	0.013889	288	24
[illegible]	0.000000	288	36

A14

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 20, 1978   11

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE RUR

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=249.331

GROUPING	MEAN	N	WEIGHT
A	24.121528	288	3
B	8.975694	288	6
B			
B	7.461806	288	9
C	1.868056	288	12
C			
C	0.010417	288	24
C			
C	0.006944	288	36

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 20, 1978   12

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LIT

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=0.142983

GROUPING	MEAN	N	HEIGHT
A	0.142361	288	3
A			
A	0.138889	288	6
B	0.052083	288	12
B			
B	0.041667	288	9
B			
B	0.000000	288	24
B			
B	0.000000	288	36

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 22, 1976   13

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE MEL

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=30.5779

GROUPING	MEAN	N	HEIGHT
A	4.579861	288	3
B	2.871528	288	6
C	0.381944	288	9
C			
C	0.170139	288	12
C			
C	0.000000	288	24
C			
C	0.000000	288	36

STATISTICAL ANALYSIS SYSTEM 13:02 THURSDAY, APRIL 2[illegible], 1978 14

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LIT_LOG

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=1674 MS=.0359272

GROUPING	MEAN	N	HEIGHT
A	0.075475	288	3
A	0.067845	288	6
B	0.023478	288	12
B	0.018664	288	9
B	0.000000	288	24
B	0.000000	288	36

```
S T A T I S T I C A L   A N A L Y S I S   S Y S T E M     13:02 THURSDAY, APRIL 20, 1978   15

          GENERAL LINEAR MODELS PROCEDURE

     DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE MEL_LOG

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

     ALPHA LEVEL=.05       DF=1674      MS=0.444345

      GROUPING                    MEAN       N    HEIGHT

             A                0.773558     288     3

             B                0.578720     288     6

             C                0.248626     288     9

             D                0.071323     288    12
             D
             D                0.000000     288    24
             D
             D                0.000000     288    36
```

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 20, 1978   16

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE CUL

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=2257.59

GROUPING	MEAN	N	SOIL
A	116.088542	576	SI
B	108.475694	576	SA
C	101.621528	576	CL

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:22 THURSDAY, APRIL 26, 1978   37

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE CHAB

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=17.4197

GROUPING	MEAN	N	SOIL
A	1.552083	576	CL
B	0.345486	576	SI
B			
B	0.303819	576	SA

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 20, 1978   15

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE BUR

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=249.331

GROUPING	MEAN	N	SOIL
A	17.097222	576	CL
B	2.152778	576	SI
B			
B	1.972222	576	SA

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:[illegible] THURSDAY, APRIL 2[illegible], 1978   15

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LIT

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=0.162983

GROUPING	MEAN	N	SOIL
A	0.079861	576	CL
A			
A	0.055556	576	SA
A			
A	0.052083	576	SI

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE MEL

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=30.8799

GROUPING	MEAN	N	SOIL
A	1.503472	576	CL
A			
A	1.460069	576	SA
A			
A	1.288194	576	SI

STATISTICAL ANALYSIS SYSTEM 15:52 THURSDAY, APRIL 20, 1978 41

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LIT_LOG

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=1674 MS=.0359277

GROUPING	MEAN	N	SOIL
A	0.036624	576	CL
A			
A	0.029609	576	SA
A			
A	0.026498	576	SI

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE MEL_LOG

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=0.444345

GROUPING	MEAN	N	SOIL
A	0.297584	576	SA
A			
A	0.275525	576	SI
A			
A	0.262994	576	CL

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:52 THURSDAY, APRIL 20, 1978   23

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE CUL

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=2257.59

GROUPING	MEAN	N	MON
A	123.589506	648	F
B	102.243056	432	O
B			
B	98.191358	648	J

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE CHAB

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=17.4197

GROUPING	MEAN	N	MON
A	0.863426	432	O
A			
A	0.739198	648	J
A			
A	0.641975	648	F

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE DUR

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=249.331

GROUPING	MEAN	N	MON
A	7.544753	648	J
A			
A	7.182870	432	O
A			
A	6.530864	648	F

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   15:02 THURSDAY, APRIL 20, 1978   26

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LIT

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=0.162983

GROUPING		MEAN	N	MON
	A	0.100309	648	F
	A			
B	A	0.069444	432	O
B				
B		0.020062	648	J

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE MEL

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=30.5799

GROUPING	MEAN	N	MON
A	2.262344	645	F
B	1.320988	646	J
C	0.293981	432	O

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LIT_LOG

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=1674 MS=.0359272

GROUPING		MEAN	N	MON
	A	0.053081	648	F
	A			
B	A	0.029695	432	O
B				
B		0.009547	648	J

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE MEL_LOG

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1674   MS=0.444345

GROUPING	MEAN	N	MON
A	0.447467	648	F
B	0.231727	648	J
C	0.096014	432	O

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 20, 1978   30

GENERAL LINEAR MODELS PROCEDURE

MEANS

HEIGHT	SOIL	N	CUL	CRAB	BUR	LIT	MEL	LIT_LOG	MEL_LOG
3	CL	96	196.552083	6.32291667	54.4583333	0.17708333	4.84375000	0.08909721	0.76432010
3	SA	96	226.302083	1.42708333	9.2187500	0.10416667	4.68750000	0.05721939	0.76662774
3	SI	96	230.187500	1.46875000	8.6875000	0.14583333	4.20833333	0.08010715	0.78966662
6	CL	96	166.343750	1.70833333	22.5729167	0.10416667	3.11458333	0.04454661	0.49172922
6	SA	96	191.739583	0.20833333	1.8854167	0.17708333	2.71875000	0.09454771	0.61451965
6	SI	96	196.250000	0.30208333	2.4687500	0.13541667	2.78125000	0.06443967	0.62991123
9	CL	96	139.375000	1.03125000	20.4375000	0.10416667	0.85416667	0.04454861	0.24442420
9	SA	96	142.229167	0.12500000	0.5000000	0.02083333	1.23958333	0.01144388	0.34414329
9	SI	96	165.322917	0.28125000	1.4479167	0.00000000	0.55208333	0.00000000	0.15731156
12	CL	96	90.729167	0.25000000	5.1145833	0.09375000	0.20833333	0.04155192	0.07748929
12	SA	96	85.531250	0.04166667	0.2291667	0.03125000	0.11458333	0.01444057	0.06021608
12	SI	96	102.072917	0.00000000	0.2604167	0.03125000	0.18750000	0.01444057	0.07626238
24	CL	96	14.625000	0.00000000	0.0000000	0.00000000	0.00000000	0.00000000	0.00000000
24	SA	96	4.385417	0.02083333	0.0000000	0.00000000	0.00000000	0.00000000	0.00000000
24	SI	96	2.614583	0.02083333	0.0312500	0.00000000	0.00000000	0.00000000	0.00000000
36	CL	96	2.104167	0.00000000	0.0000000	0.00000000	0.00000000	0.00000000	0.00000000
36	SA	96	0.166667	0.00000000	0.0000000	0.00000000	0.00000000	0.00000000	0.00000000
36	SI	96	0.083333	0.00000000	0.0208333	0.00000000	0.00000000	0.00000000	0.00000000

HEIGHT	MON	N	CUL	CRAB	BUR	LIT	MEL	LIT_LOG	MEL_LOG
3	F	108	259.490741	2.62962963	22.0925926	0.30555556	7.18518519	0.16057621	1.29220675
3	J	108	196.861111	3.00925926	24.0925926	0.03703704	4.40740741	0.02034467	0.59659094
3	O	72	186.861111	3.83333333	27.2083333	0.05555556	0.93055556	0.03051701	0.26195608
6	F	108	212.046296	0.79629630	11.0648148	0.21296296	5.10185185	0.11455942	0.99443759
6	J	108	167.379630	0.75000000	9.0740741	0.03703704	2.17592593	0.02034467	0.42652622
6	O	72	169.222222	0.63888889	5.6944444	0.18055556	0.56944444	0.06902518	0.18343462
9	F	108	151.203704	[illegible]	4.0740741	0.06481481	1.10185185	0.03318073	0.35803956
9	J	108	146.935185	0.58333333	10.2592593	0.04629630	1.16666667	0.01659037	0.27702900
9	O	72	146.694444	0.61111111	8.3472222	0.00000000	0.12500000	0.00000000	0.05540256
12	F	108	113.175926	0.12037037	1.9537037	0.01851852	0.18518519	0.01017234	0.07011577
12	J	108	74.092593	0.39259259	1.8240741	0.00000000	0.17592593	0.00000000	0.06921610
12	O	72	90.208333	0.36944444	1.8055556	0.18055556	0.13888889	0.07865223	0.07629252
24	F	108	5.620370	0.01851852	0.0000000	0.00000000	0.00000000	0.00000000	0.00000000
24	J	108	2.740741	0.00000000	0.0000000	0.00000000	0.00000000	0.00000000	0.00000000
24	O	72	16.291667	0.02777778	0.0416667	0.00000000	0.00000000	0.00000000	0.00000000
36	F	108	0.000000	0.00000000	0.0000000	0.00000000	0.00000000	0.00000000	0.00000000
36	J	108	0.659889	0.00000000	0.0185185	0.00000000	0.00000000	0.00000000	0.00000000
36	O	72	2.180556	0.00000000	0.0000000	0.00000000	0.00000000	0.00000000	0.00000000

SOIL	MON	N	CUL	CRAB	BUR	LIT	MEL	LIT_LOG	MEL_LOG
CL	F	216	119.157407	1.38425926	16.4351852	0.11111111	2.57870370	0.05618913	0.43907546
CL	J	216	87.453333	1.53703704	17.8796296	0.02314815	1.29166667	0.00829518	0.23015980
CL	O	144	96.000000	1.81944444	16.9166667	0.11805556	0.20833333	0.04977110	0.08127233
SA	F	216	128.162037	0.43981481	2.2083333	0.09722222	2.00000000	0.05219354	0.43247857
SA	J	216	75.106481	0.23611111	1.9351852	0.03703704	1.23148148	0.02034467	0.29430367
SA	O	144	99.000000	0.20138889	1.6736111	0.02083333	0.30555556	0.00962704	0.10016450

GENERAL LINEAR MODELS PROCEDURE

MEANS

SOIL	MON	N	CUL	CRAB	BUR	LIT	MEL	LIT_LOG	MEL_LOG
SI	F	216	123.449074	0.39722222	0.9490741	0.09259259	2.20833333	0.65086168	0.47084576
SI	J	216	111.634259	0.44444444	2.8194444	0.00000000	0.96814814	0.00000000	0.19281766
SI	L	144	111.729167	0.55944444	2.9583333	0.16944444	[illegible]	0.02969907	0.10650606

PART 2

GENERAL LINEAR MODELS PROCEDURE

CLASS LEVEL INFORMATION

CLASS	LEVELS	VALUES
HEIGHT	6	3 6 9 12 24 36
CONTROL	2	0 1

NUMBER OF OBSERVATIONS IN DATA SET = 1944

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: CUL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	11	13773965.12332819	1252178.64757529	402.67	0.0001	0.696290	47.4017
ERROR	1932	6007961.12152778	3109.71072543		STD DEV		CUL MEAN
CORRECTED TOTAL	1943	19781926.24485597			55.76478033		117.64300412

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	11905136.24485597	765.67	0.0001	5	3054751.13303757	196.47	0.0001
CONTROL	1	1235867.91210134	397.42	0.0001	1	1235867.91210134	397.42	0.0001
HEIGHT*CONTROL	5	632960.96637088	40.71	0.0001	5	632960.96637088	40.71	0.0001

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: CRAB

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	11	3209.17772634	291.74342967	14.72	0.0001	0.077347	462.0063
ERROR	1932	38281.22916667	19.81430081		STD DEV		CRAB MEAN
CORRECTED TOTAL	1943	41490.40689300			4.45132574		0.96347737

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	2001.99022634	20.21	0.0001	5	724.67206790	7.31	0.0001
CONTROL	1	820.42078187	41.41	0.0001	1	820.42078189	41.41	0.0001
HEIGHT*CONTROL	5	386.76671811	3.90	0.0017	5	386.76671811	3.90	0.0017

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 20, 1978   35

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: DUR

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	11	127119.73611111	11556.33964646	33.67	0.0001	0.160860	251.6819
ERROR	1932	663126.76388889	343.23434984		STD DEV		DUR MEAN
CORRECTED TOTAL	1943	790246.50000000			18.52658495		7.36111111

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	117276.68518519	68.34	0.0001	5	26397.67644033	15.38	0.0001
CONTROL	1	1281.33333333	3.73	0.0535	1	1281.33333333	3.73	0.0535
HEIGHT*CONTROL	5	8561.71759259	4.99	0.0002	5	8561.71759259	4.99	0.0002

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LIT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	11	36.46630658	3.31511878	5.14	0.0001	0.028430	934.9059
ERROR	1932	1246.18750000	0.64502459		STD DEV		LIT MEAN
CORRECTED TOTAL	1943	1282.65380658			0.80313423		0.08590535

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	7.25565944	2.25	0.0466	5	19.77752058	6.13	0.0001
CONTROL	1	8.51954733	13.21	0.0003	1	8.51954733	13.21	0.0003
HEIGHT*CONTROL	5	20.69110082	6.42	0.0001	5	20.69110082	6.42	0.0001

STATISTICAL ANALYSIS SYSTEM 13:02 THURSDAY, APRIL 20, 1978 37

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: REL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	11	8825.54745370	802.32249579	19.37	0.0001	0.099351	365.4666
ERROR	1932	80006.22569444	41.41108990		STD DEV		REL MEAN
CORRECTED TOTAL	1943	88831.77314815			6.43514490		1.76080247

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	6159.88117284	29.75	0.0001	5	3543.20942644	17.11	0.0001
CONTROL	1	1835.62557870	44.33	0.0001	1	1835.62557870	44.33	0.0001
HEIGHT*CONTROL	5	830.04070216	4.01	0.0014	5	830.04070216	4.01	0.0014

STATISTICAL ANALYSIS SYSTEM 13:07 THURSDAY, APRIL 20, 1978 52

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LIT_LOG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	11	2.60343167	0.23668015	5.01	0.0001	0.027716	599.7729
ERROR	1932	91.33207295	0.04727333		STD DEV		LIT_LOG MEAN
CORRECTED TOTAL	1943	93.93555462			0.21742431		0.03625111

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	1.46744246	6.21	0.0001	5	0.69845670	2.95	0.0117
CONTROL	1	0.44360997	9.38	0.0022	1	0.44360997	9.38	0.0022
HEIGHT*CONTROL	5	0.69242924	2.93	0.0123	5	0.69242924	2.93	0.0123

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: MEL_LOG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	11	215.98606394	19.63509672	33.93	0.0001	0.161924	230.4965
ERROR	1932	1117.88720853	0.57861657		STD DEV		MEL_LOG MEAN
CORRECTED TOTAL	1943	1333.87327248			0.76066850		0.33001297

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	166.43448739	57.53	0.0001	5	63.28406141	21.87	0.0001
CONTROL	1	40.94684235	70.77	0.0001	1	40.94684235	70.77	0.0001
HEIGHT*CONTROL	5	8.60473423	2.97	0.0112	5	8.60473420	2.97	0.0112

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE CPL

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1937   MS=3109.71

GROUPING	MEAN	N	HEIGHT
A	217.777778	324	3
B	187.200617	324	6
C	159.277778	324	9
D	105.626543	324	12
E	26.317901	324	24
F	9.657407	324	36

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE CRAB

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1932   MS=19.8147

GROUPING		MEAN	N	HEIGHT
	A	3.104938	324	3
	B	1.018519	324	9
	B			
C	B	0.947531	324	6
C				
C	D	0.283951	324	36
C	D			
C	D	0.240741	324	12
	D			
	D	0.185185	324	24

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE BUR

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1932   MS=343.234

GROUPING	MEAN	N	HEIGHT
A	23.194444	324	[illegible]
B	8.799383	324	6
B			
B	8.064815	324	9
C	2.018519	324	12
C			
C	1.475309	324	36
C			
C	0.614198	324	24

```
S T A T I S T I C A L   A N A L Y S I S   S Y S T E M      13:02 THURSDAY, APRIL 2[illegible], 1976   43

                 GENERAL LINEAR MODELS PROCEDURE

           DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LIT

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

         ALPHA LEVEL=.05        DF=1932      MS=0.645025

         GROUPING                     MEAN       N      HEIGHT

                 A                0.151235     324      12
                 A
         B       A                0.141975     324       6
         B       A
         B       A                0.132716     324       3
         B       A
         B       A                0.077160     324       9
         B
         B                        0.006173     324      24
         B
         B                        0.006173     324      36
```

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 20, 1978   44

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE MEL

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1942   MS=41.4111

GROUPING	MEAN	N	HEIGHT
A	4.864198	324	3
B	3.299383	324	6
C	1.691358	324	9
D	0.373457	324	12
D			
D	0.243827	324	24
D			
D	0.092593	324	36

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 20, 1978   45

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LIT_LOG

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1942   MS=.0672243

GROUPING		MEAN	N	HEIGHT
	A	0.070479	324	6
	A			
	A	0.070479	324	3
	A			
B	A	0.038249	324	12
B				
B		0.031517	324	9
B				
B		0.003391	324	24
B				
B		0.003391	324	36

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE MEL_LOG

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1932   MS=0.578617

GROUPING	MEAN	N	WEIGHT
A	0.805374	324	3
B	0.615666	324	6
C	0.345638	324	9
D	0.124502	324	12
D			
D	0.061000	324	24
D			
D	0.027898	324	36

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE CUL

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=1932 MS=3109.71

GROUPING	MEAN	N	CONTROL
A	188.958333	216	1
B	108.728588	1726	0

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE CRAH

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1932   MS=19.8143

GROUPING	MEAN	N	CONTROL
A	2.800926	216	1
B	0.773796	1728	0

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE HUR

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1932   MS=343.234

GROUPING	MEAN	N	CONTROL
A	9.657407	216	1
A			
A	7.074074	1728	0

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:[illegible] THURSDAY, APRIL 2[illegible], 1978   5[illegible]

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LIT

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1932   MS=0.645[illegible]

GROUPING	MEAN	N	CONTROL
A	0.273148	216	1
B	0.062500	1728	0

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 20, 1978   51

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE MFL

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1932   MS=41.4111

GROUPING	MEAN	N	CONTROL
A	4.509259	216	1
B	1.417245	1728	0

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 20, 1978   52

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LIT_LOG

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1932   MS=.0472743

GROUPING	MEAN	N	CONTROL
A	0.078978	216	1
B	0.030910	1728	0

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE MEL_LOG

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=1932   MS=0.578617

GROUPING	MEAN	N	CONTROL
A	0.740507	216	1
B	0.278701	1728	0

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   13:02 THURSDAY, APRIL 20, 1978   54

GENERAL LINEAR MODELS PROCEDURE

MEANS

HEIGHT	CONTROL	N	CUL	CRAB	DUR	LIT	MEL	LIT_LOG	MEL_LOG
3	0	288	217.[illegible]47222	3.07291667	24.1215278	0.14236111	4.579[illegible]111	0.07547458	0.77353815
3	1	36	217.222222	3.36111111	19.7777778	0.05555556	7.13888889	0.03051701	1.0[illegible]6278
6	0	288	144.777778	1.73958333	[illegible].9756944	0.13888889	2.87152778	0.06784533	0.51672005
6	1	36	206.583333	2.61111111	7.38888889	0.16666667	6.72222222	0.09155102	0.91173520
9	0	288	148.975694	0.47916667	7.4618056	0.04166667	0.88194444	0.01366416	0.24862635
9	1	36	241.694444	5.33333333	12.8888889	0.36111111	2.16666667	0.13434116	1.12173128
12	0	288	92.777778	0.09722222	1.8680556	0.05208333	0.17013889	0.02347768	0.07132258
12	1	36	206.416667	1.38888889	3.2222222	0.94444444	2.00000000	0.15642255	0.54993316
24	0	288	7.208333	0.01388889	0.0104167	0.00000000	0.00000000	0.00000000	0.00000000
24	1	36	179.194444	1.55555556	5.4444444	0.05555556	2.19444444	0.03051701	0.54900197
36	0	288	0.784722	0.00000000	0.0069444	0.00000000	0.00000000	0.00000000	0.00000000
36	1	36	80.638889	2.55555556	13.2222222	0.05555556	0.83333333	0.03051701	0.25107889

PART 3

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   7:50 THURSDAY, DECEMBER 22, 1977

GENERAL LINEAR MODELS PROCEDURE

CLASS LEVEL INFORMATION

CLASS	LEVELS	VALUES
CONT2	2	0 1

NUMBER OF OBSERVATIONS IN DATA SET = 1936

NOTE: ALL DEPENDENT VARIABLES ARE CONSISTENT WITH RESPECT TO THE PRESENCE OR ABSENCE OF MISSING VALUES. HOWEVER, ONLY 1972 OBSERVATIONS IN DATA SET CAN BE USED IN THIS ANALYSIS.

GENERAL LINEAR MODELS PROCEDURE

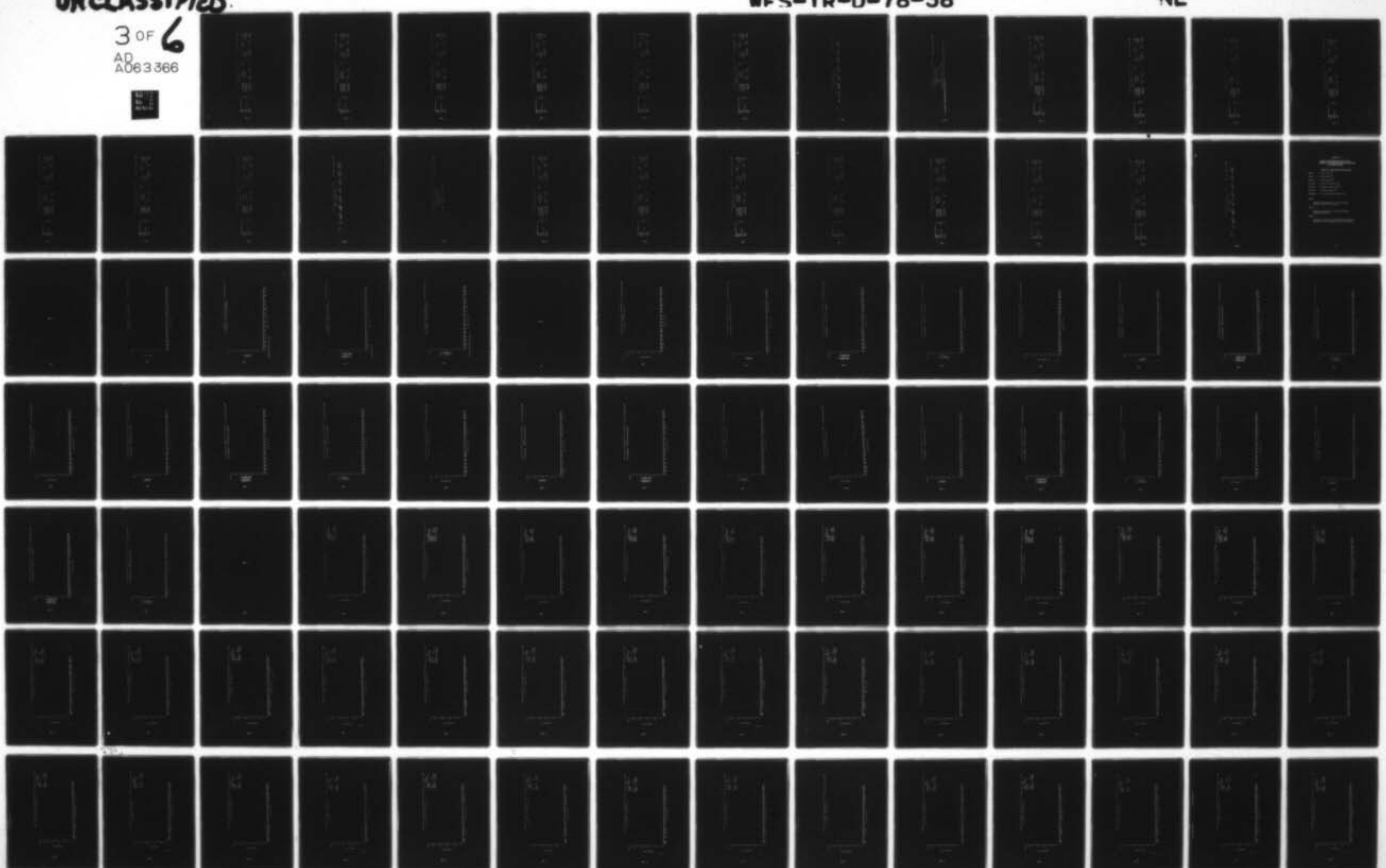
DEPENDENT VARIABLE: CUL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	169484.09368739	169484.09368739	16.81	0.0001	0.008451	85.2891
ERROR	1970	19861622.21868584	10082.04173537		STD DEV		CUL MEAN
CORRECTED TOTAL	1971	20031106.31237323			100.40937075		117.72819473

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONT2	1	169484.09368739	16.81	0.0001	1	169484.09368739	16.81	0.0001

AD-A063 366 GEORGIA UNIV BRUNSWICK MARINE EXTENSION SERVICE F/G 13/2
THE EFFECTS OF SMOTHERING A 'SPARTINA ALTERNIFLORA' SALT MARSH --ETC(U)
JUL 78 R J REIMOLD, M A HARDISKY, P C ADAMS DACW21-75-C-0074
UNCLASSIFIED WES-TR-D-78-38 NL

3 OF 6
AD
A063366



ASSIFIE

3 OF 6

AD
A063366

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   7:50 THURSDAY, DECEMBER 22, 1977 3

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: CRAB

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	343.97207725	343.97207725	16.91	0.0001	0.008513	456.7380
ERROR	1970	40060.71098563	20.33538629		STD DEV		CRAB MEAN
CORRECTED TOTAL	1971	40404.68306288			4.50947739		0.98732252

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONT2	1	343.97207725	16.91	0.0001	1	343.97207725	16.91	0.0001

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   7:50 THURSDAY, DECEMBER 22, 1977   4

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: BUR

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	26886.21564480	26886.21564480	65.34	0.0001	0.032101	266.5991
ERROR	1970	810665.34368583	411.50525060		STD DEV		BUR MEAN
CORRECTED TOTAL	1971	837551.55933063			20.28559219		7.60902637

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONT2	1	26886.21564480	65.34	0.0001	1	26886.21564480	65.34	0.0001

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LIT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	10.46125844	10.46125844	15.03	0.0001	0.007572	889.3031
ERROR	1970	1371.18326489	0.69603211		STD DEV		LIT MEAN
CORRECTED TOTAL	1971	1381.64452333			0.83428539		0.09381339

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONT2	1	10.46125844	15.03	0.0001	1	10.46125844	15.03	0.0001

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: MEL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	445.58629870	445.58629870	9.93	0.0017	0.005015	380.7967
ERROR	1970	88398.99940110	44.87258853		STD DEV		MEL MEAN
CORRECTED TOTAL	1971	88844.58569980			6.69870051		1.75912779

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONT2	1	445.58629870	9.93	0.0017	1	445.58629870	9.93	0.0017

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   7:50 THURSDAY, DECEMBER 22, 1977

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LIT_LOG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	1.53983216	1.53983216	29.52	0.0001	0.014765	581.4472
ERROR	1970	102.75259653	0.05215868		STD DEV		LIT_LOG MEAN
CORRECTED TOTAL	1971	104.29242869			0.22838275		0.03927833

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONTR	1	1.53983216	29.52	0.0001	1	1.53983216	29.52	0.0001

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: MEL_LOG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	15.50829864	15.50829864	22.78	0.0001	0.011433	248.4438
ERROR	1970	1340.95491137	0.68068777		STD DEV		MEL_LOG MEAN
CORRECTED TOTAL	1971	1356.46321001			0.82503404		0.33208236

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONT2	1	15.50829864	22.78	0.0001	1	15.50829864	22.78	0.0001

GENERAL LINEAR MODELS PROCEDURE

MEANS

CONTR	N	FUL	CRAG	BUR	LIT	MEL	LIT_LOG	MEL_LOG
0	1948	116.699179	0.94096509	7.1991786	0.08572895	1.70636550	0.03617667	0.32223908
1	24	201.250000	4.75000000	40.8750000	0.75000000	6.04166667	0.29102985	1.13102846

GENERAL LINEAR MODELS PROCEDURE

CLASS LEVEL INFORMATION

CLASS	LEVELS	VALUES
CONT3	2	0 1

NUMBER OF OBSERVATIONS IN DATA SET = 1986

NOTE: ALL DEPENDENT VARIABLES ARE CONSISTENT WITH RESPECT TO THE PRESENCE OR ABSENCE OF MISSING VALUES. HOWEVER, ONLY 1962 OBSERVATIONS IN DATA SET CAN BE USED IN THIS ANALYSIS.

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: CUL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	194063.55581540	194063.55581540	19.18	0.0001	0.009692	85.5730
					STD DEV		CUL MEAN
ERROR	1960	19829795.43277155	10117.24256784				
CORRECTED TOTAL	1961	20023858.98378695			100.58450161		117.54230377

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONT3	1	194063.55581540	19.18	0.0001	1	194063.55581540	19.18	0.0001

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: CRAB

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	91.02703680	91.02703680	4.51	0.0339	0.002293	468.6065
ERROR	1960	39601.71098563	20.20495458		STD DEV		CRAB MEAN
CORRECTED TOTAL	1961	39692.73802243			4.49499217		0.95922528

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONT3	1	91.02703680	4.51	0.0339	1	91.02703680	4.51	0.0339

STATISTICAL ANALYSIS SYSTEM 7:53 THURSDAY, DECEMBER 22, 1977

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: BUP

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	1111.86060644	1111.86060644	2.88	0.0901	0.001465	270.7325
ERROR	1960	757824.43297155	386.64511886		STD DEV		BUP MEAN
CORRECTED TOTAL	1961	758936.29357798			19.66329369		7.26299694

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONTB	1	1111.86060644	2.88	0.0901	1	1111.86060644	2.88	0.0901

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LIT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	0.22972477	0.22972477	0.35	0.5549	0.000178	936.6815
ERROR	1960	1291.04040774	0.65869409		STD DEV		LIT MEAN
CORRECTED TOTAL	1961	1291.27013252			0.81159971		0.08664628

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONT3	1	0.22972477	0.35	0.5549	1	0.22972477	0.35	0.5549

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: MEL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	3342.91320630	3342.91320630	66.98	0.0001	0.033046	388.7020
ERROR	1960	97816.39821062	49.90632562		STD DEV		MEL MEAN
CORRECTED TOTAL	1961	101159.31141692			7.06444393		1.81702345

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONT3	1	3342.91320630	66.98	0.0001	1	3342.91320630	66.98	0.0001

STATISTICAL ANALYSIS SYSTEM

7:50 THURSDAY, DECEMBER 22, 1977

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LIT_LOG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	0.05489724	0.05489724	1.12	0.2892	0.000573	603.4018
ERROR	1960	95.72534016	0.04883746		STD DEV		LIT_LOG MEAN
CORRECTED TOTAL	1961	95.78023741			0.22099651		0.03662510

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CINT3	1	0.05489724	1.12	0.2892	1	0.05489724	1.12	0.2892

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: MEL_LOG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	25.58297936	25.58297936	37.41	0.0001	0.018731	249.1346
ERROR	1960	1340.26206719	0.68380714		STD DEV		MEL_LOG MEAN
CORRECTED TOTAL	1961	1365.84504655			0.82692634		0.33191953

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CINT3	1	25.58297936	37.41	0.0001	1	25.58297936	37.41	0.0001

GENERAL LINEAR MODELS PROCEDURE

MEANS

CONT3	N	CUL	CRAB	BUR	LIT	MEL	LIT_LOG	MEL_LOG
0	1948	116.699179	0.94090509	7.1991736	0.38572895	1.7063655	0.03617667	0.32223908
1	14	234.857143	3.50000000	16.1428571	0.21428571	17.2142857	0.09902103	1.57888517

GENERAL LINEAR MODELS PROCEDURE

CLASS LEVEL INFORMATION

CLASS	LEVELS	VALUES
CONTROL	2	0 1

NUMBER OF OBSERVATIONS IN DATA SET = 1948

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   7:53 THURSDAY, DECEMBER 22, 1977   20

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: CUL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	1307789.57711483	1307789.57711483	137.79	0.0001	0.066126	83.4311
ERROR	1946	18469490.14157100	9491.00212825		STD DEV		CUL MEAN
CORRECTED TOTAL	1947	19777279.71868584			97.42177441		116.63917864

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONTROL	1	1307789.57711483	137.79	0.0001	1	1307789.57711483	137.79	0.0001

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: CRAB

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	818.72921481	818.72921481	41.45	0.0001	0.020858	472.2913
ERROR	1946	38433.48177081	19.74999363		STD DEV		CRAB MEAN
CORRECTED TOTAL	1947	39252.21098563			4.44409615		0.94096509

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONTROL	1	818.72921481	41.45	0.0001	1	818.72921481	41.45	0.0001

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

7:50 THURSDAY, DECEMBER 22, 1977

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: BUR

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	1324.39130785	1324.39130785	3.42	0.0645	0.001756	273.2335
ERROR	1946	752969.32737798	386.93130903		STD DEV		BUR MEAN
CORRECTED TOTAL	1947	754292.71868583			19.67056952		7.19917864

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONTROL	1	1324.39130785	3.42	0.0645	1	1324.39130785	3.42	0.0645

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LIT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	8.32433807	8.32433807	12.71	0.0004	0.006490	943.9456
ERROR	1946	1274.35892682	0.65486373		STD DEV		LIT MEAN
CORRECTED TOTAL	1947	1282.68326489			0.80923464		0.08572895

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONTROL	1	8.32433807	12.71	0.0004	1	8.32433807	12.71	0.0004

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: MEL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	1966.78416365	1966.78416365	45.35	0.0001	0.022778	335.8996
ERROR	1946	84379.25690411	43.36335812		STD DEV		MEL MEAN
CORRECTED TOTAL	1947	86346.04106776			6.58485325		1.73636550

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONTROL	1	1966.78416365	45.36	0.0001	1	1966.78416365	45.36	0.0001

STATISTICAL ANALYSIS SYSTEM   7:50 THURSDAY, DECEMBER 22, 1977   25

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LIT_LOG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	0.42944479	0.42944479	8.94	0.0028	0.004571	605.9436
ERROR	1946	93.51135560	0.04805311		STD DEV		LIT_LOG MEAN
CORRECTED TOTAL	1947	93.94080040			0.21921020		0.03617667

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONTROL	1	0.42944479	8.94	0.0028	1	0.42944479	8.94	0.0028

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: MEL_LOG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	43.14368139	43.14368139	66.70	0.0001	0.033141	249.5794
ERROR	1946	1258.68359501	0.64680555		STD DEV		MEL_LOG MEAN
CORRECTED TOTAL	1947	1301.82727639			0.80424222		0.32223908

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
CONTROL	1	43.14368139	66.70	0.0001	1	43.14368139	66.70	0.0001

GENERAL LINEAR MODELS PROCEDURE

MEANS

CONTROL	N	GUL	CRAB	BUR	LIT	MEL	LIT_LOG	MEL_LOG
0	1729	127.477733	0.71023713	6.90572585	0.05246385	1.34875551	0.33089242	0.26927412
1	219	189.502283	2.76255708	9.51598174	0.26940639	4.52968037	0.37789574	0.74039627

APPENDIX B

GRAPHIC REPRESENTATION OF DEPENDENT VARIABLES FOR MARSH SMOTHERING EXPERIMENTAL AND CONTROL AREAS

Legend for Dependent Variable Codes

Culm_d	=	Live culms /m^2
Crabs	=	Live crabs /m^2
Burrows	=	Crab burrows /m^2
Littorin	=	*Littorina irrorata* /m^2
Melampus	=	*Melampus bidentatus* /m^2
Flowerin	=	Flowering culms /m^2
Seedling	=	*S. alterniflora* seedlings /m^2

PART 1

Dependent variables for 3m x 3m enclosure controls versus sampling data.

PART 2

Dependent variables for control enclosure vesus sampling date.

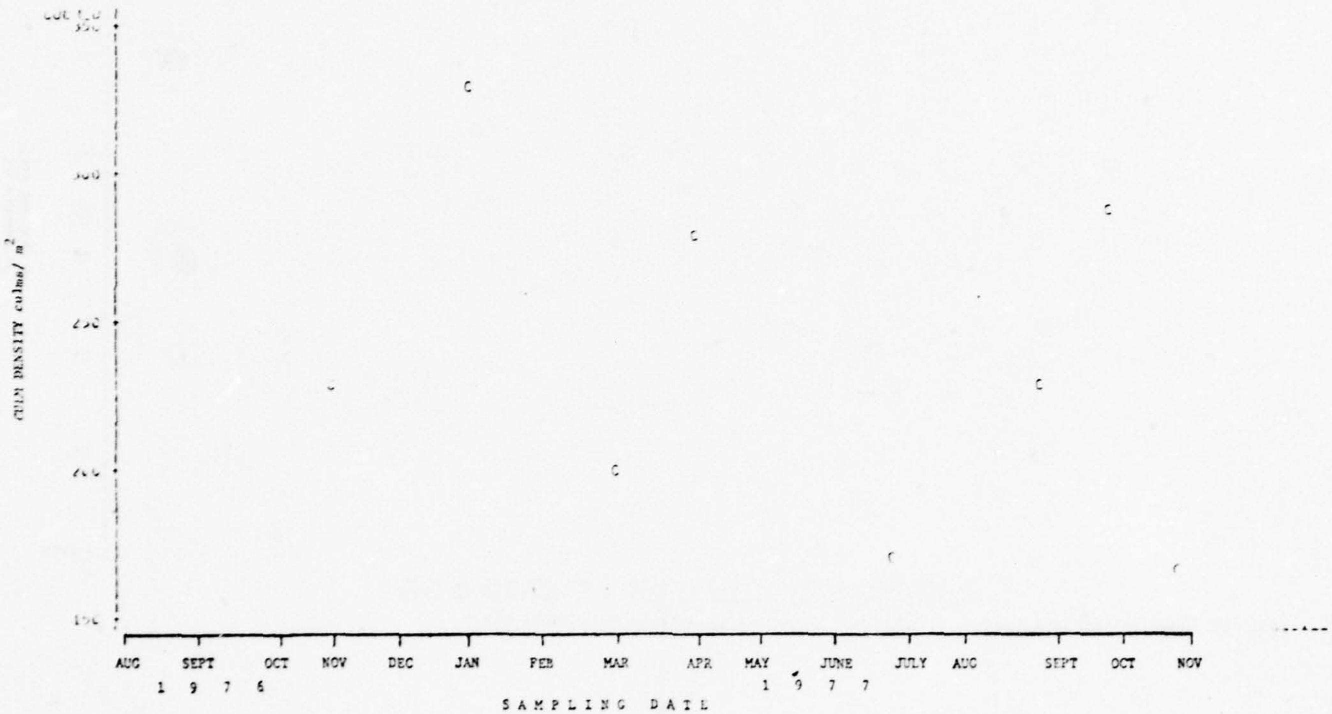
PART 3

Dependent variables for experimental enclosures by height, soil and month versus sampling date.

PART 1

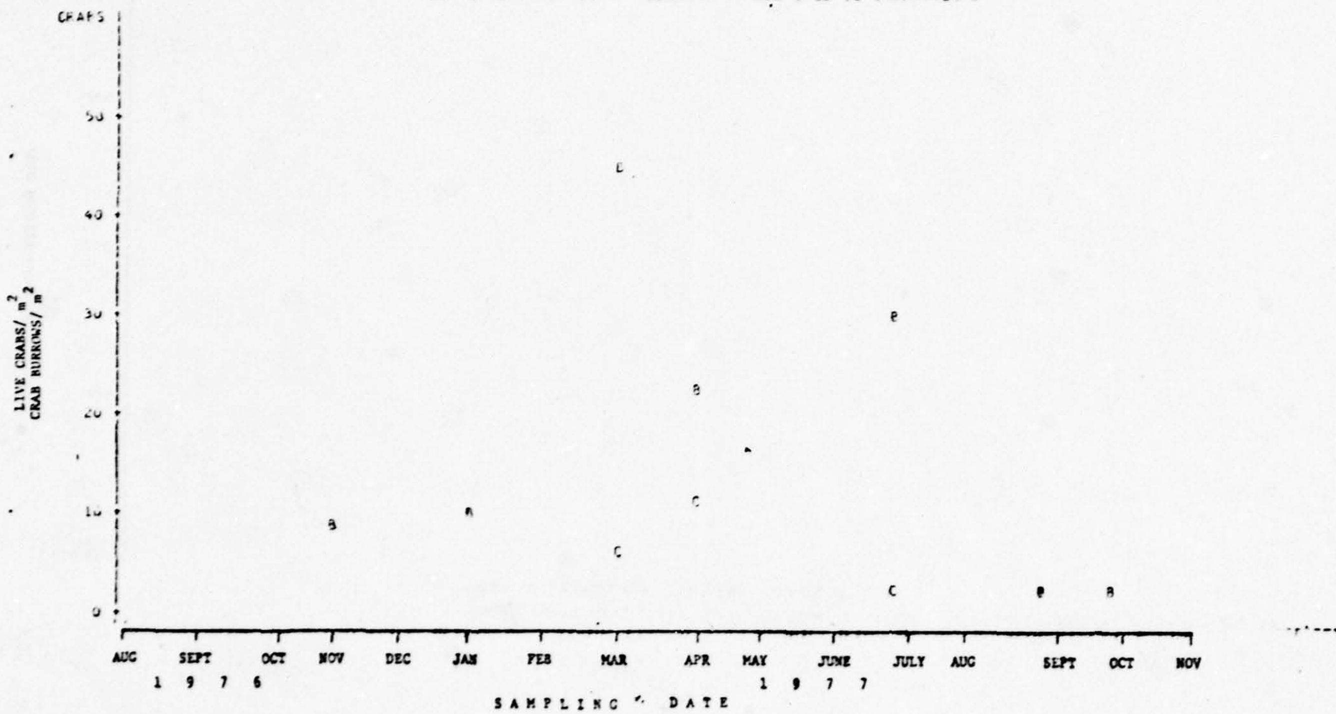
MARSH SMOOTHING (10×10) FEET ENCLOSURE CONTROLS   3:01 TUESDAY, DECEMBER 20, 1977   1

PLOT OF DAY*CUL4_D   LEGEND: SYMBOL USED IS C



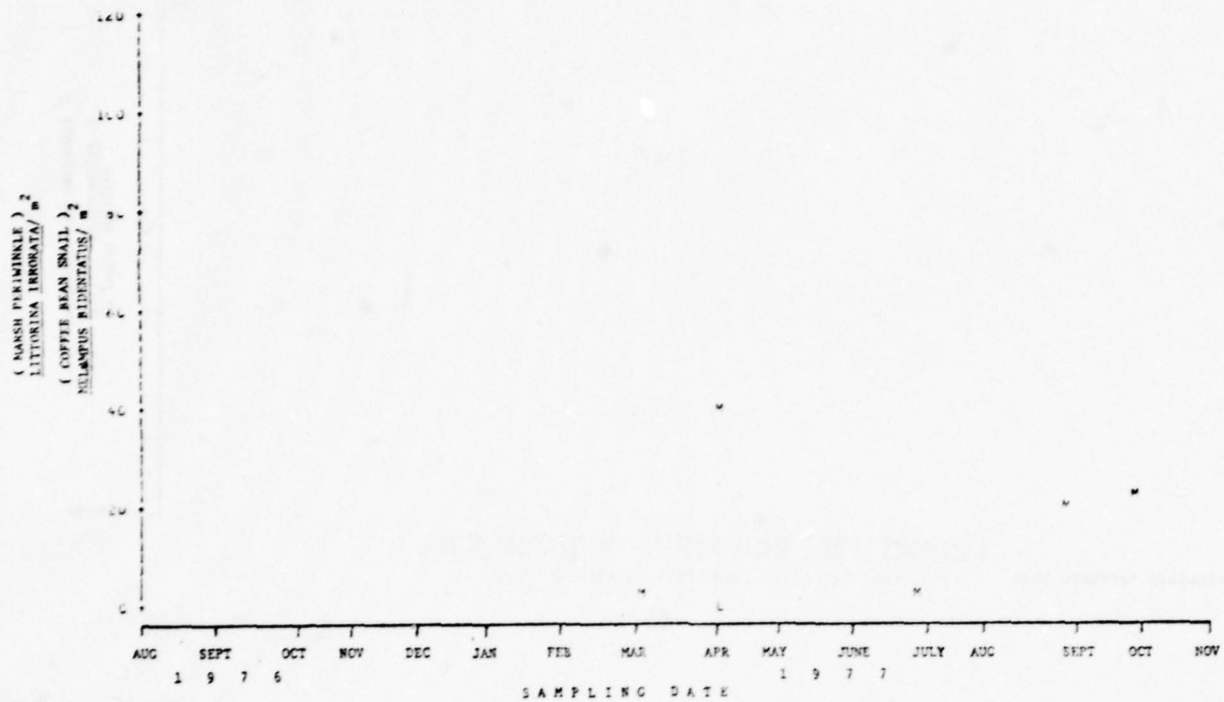
MARSH SMOTHERING 10*10 FEET ENCLOSURE CONTROLS 3:01 TUESDAY, DECEMBER 20, 1977 2

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



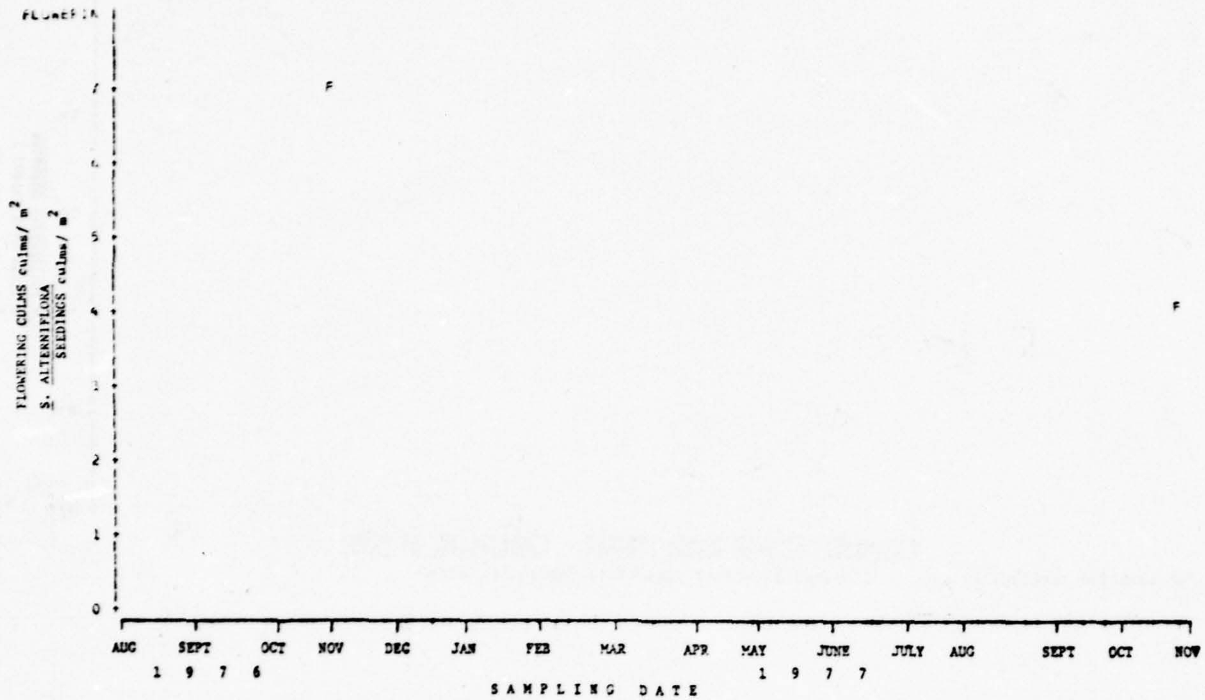
MARSH SMOTHERING 10*10 FEET ENCLOSURE CONTROLS 3:01 TUESDAY, DECEMBER 20, 1977 3

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



MARSH SMOTHERING 10+10 FEET ENCLOSURE CONTROLS 3:01 TUESDAY, DECEMBER 20, 1977 4

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

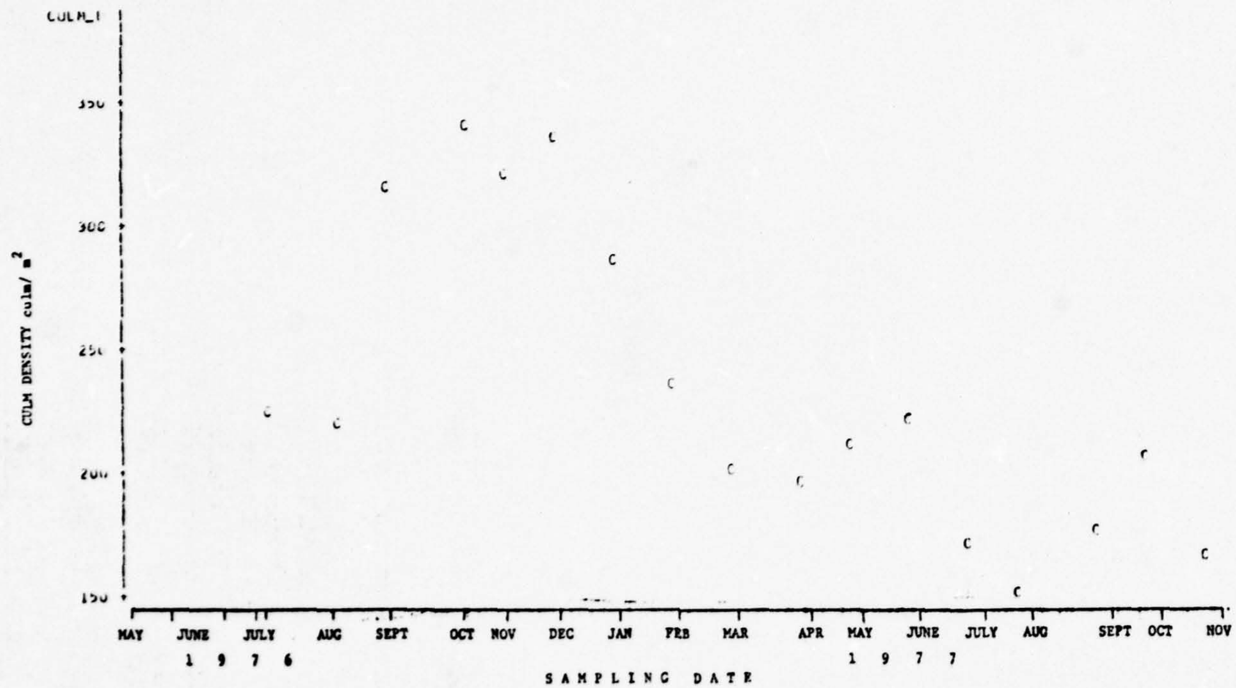


PART 2

CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977

HEIGHT=3

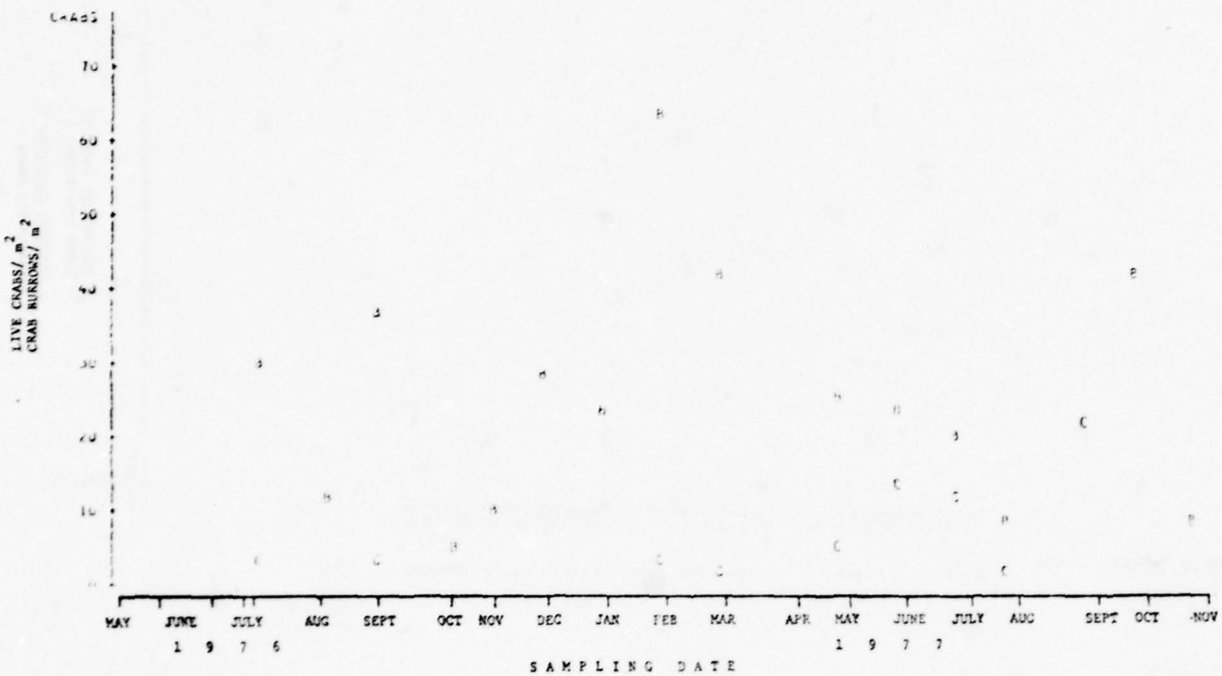
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977 2

HEIGHT=3

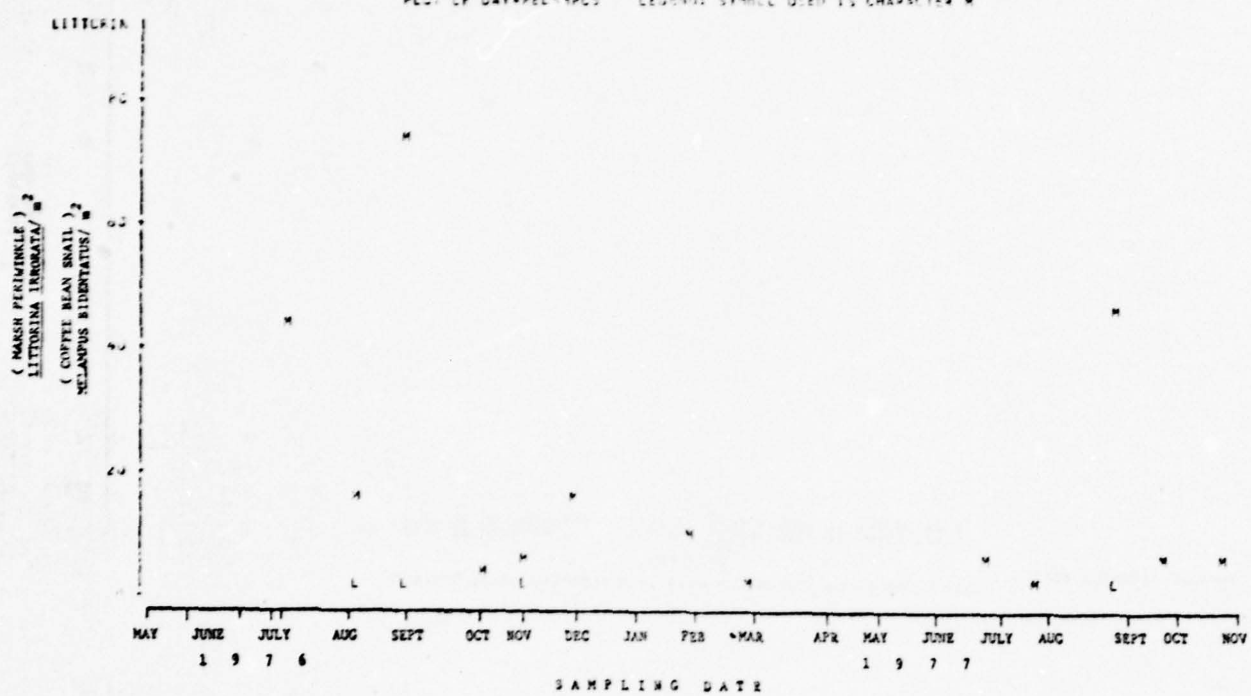
PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING   11:31 TUESDAY, DECEMBER 20, 1977 3

HEIGHT=3

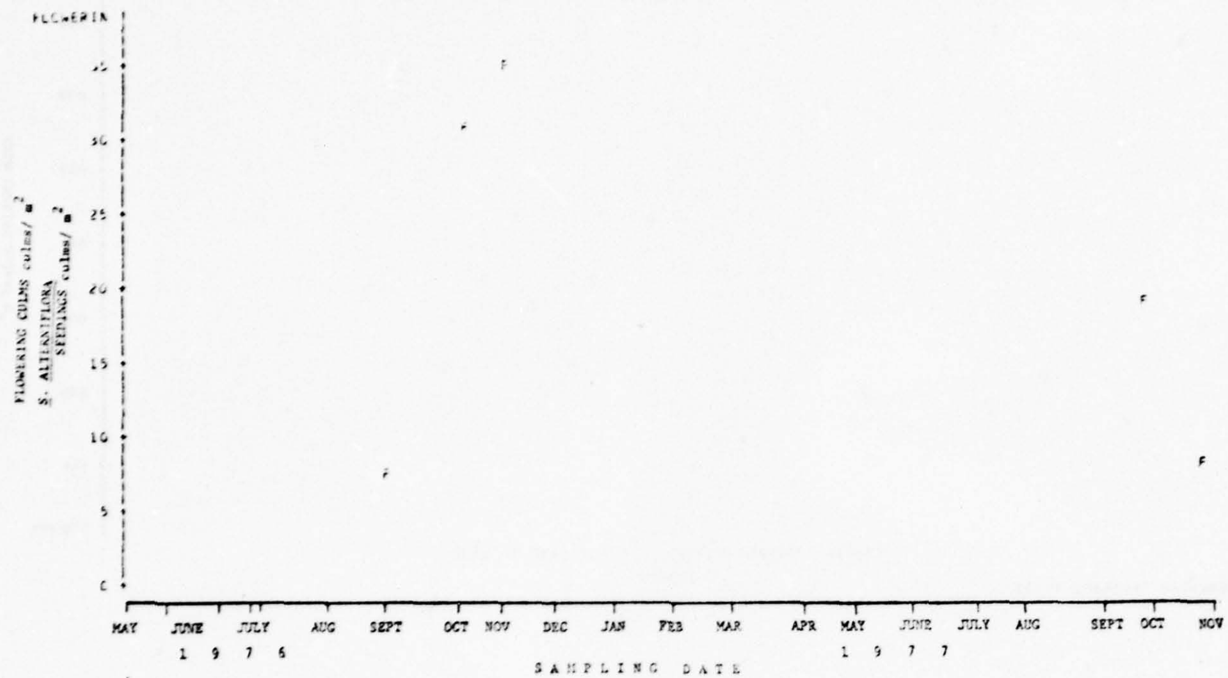
PLOT OF DAY*LITTORIN   LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS   LEGEND: SYMBOL USED IS CHARACTER M



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977 4

HEIGHT=3

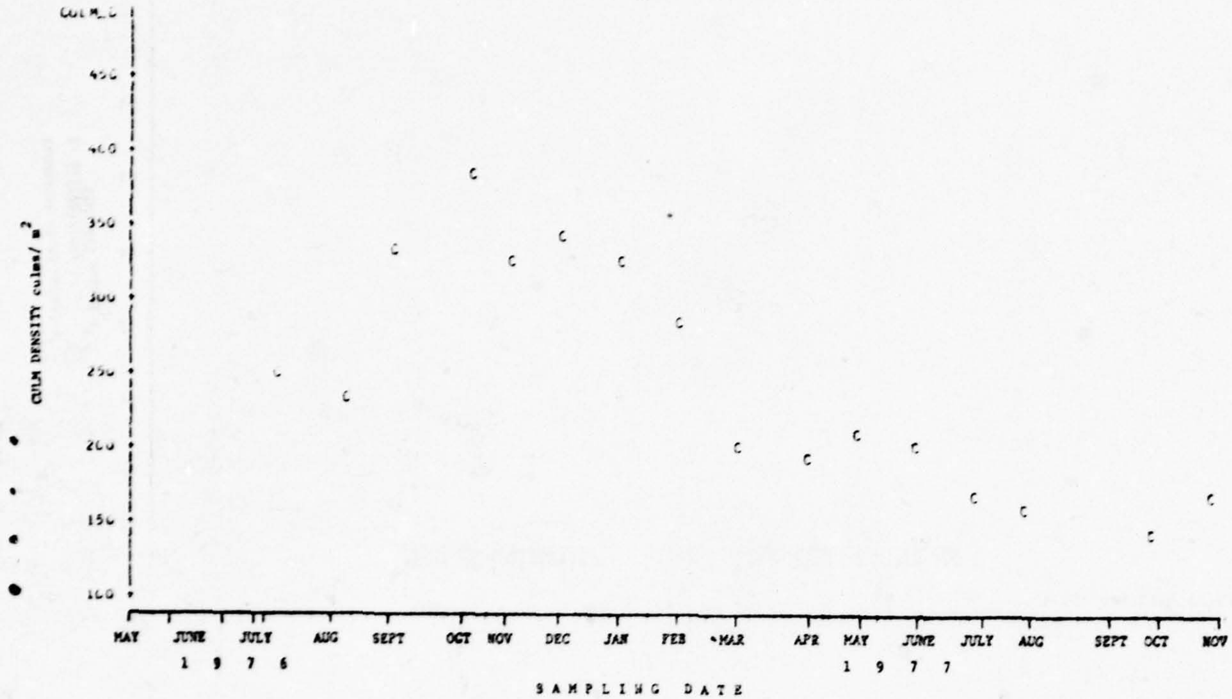
PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



CONTROL PIPES EVALLATION AT EACH HEIGHT FOR MARSH SMOTHERING   11:31 TUESDAY, DECEMBER 20, 1977 5

HEIGHT=6

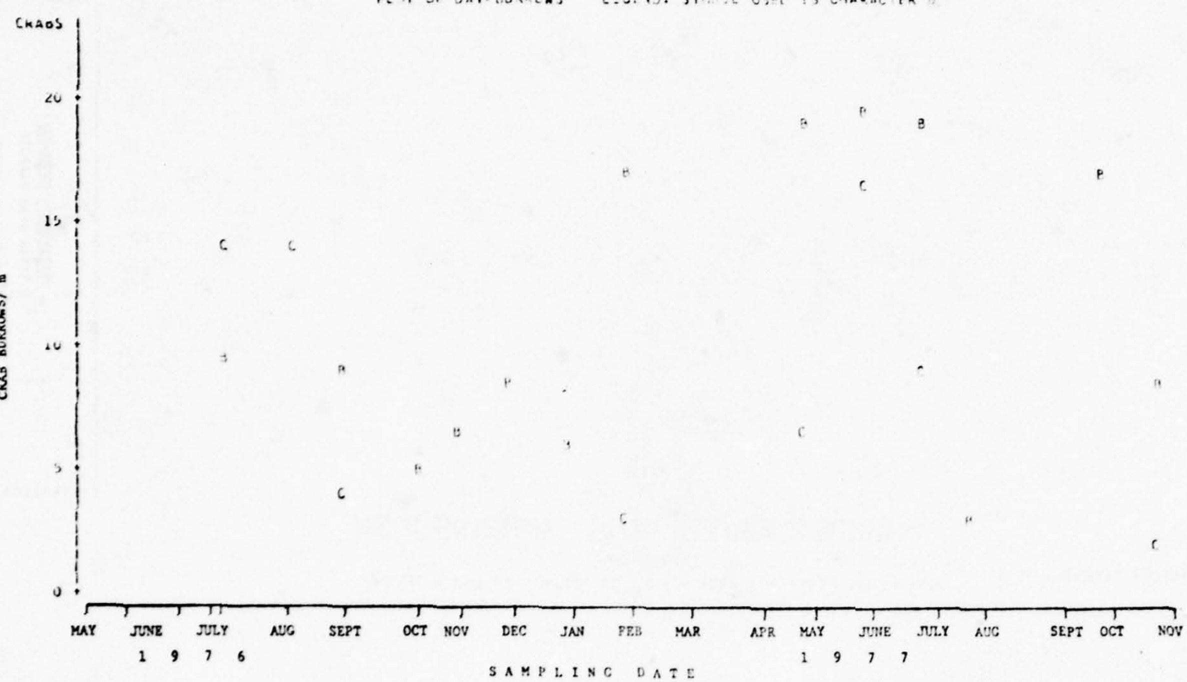
PLOT OF DAY*CULM_D   LEGEND: SYMBOL USED IS C



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING   11:31 TUESDAY, DECEMBER 20, 1977

HEIGHT=6

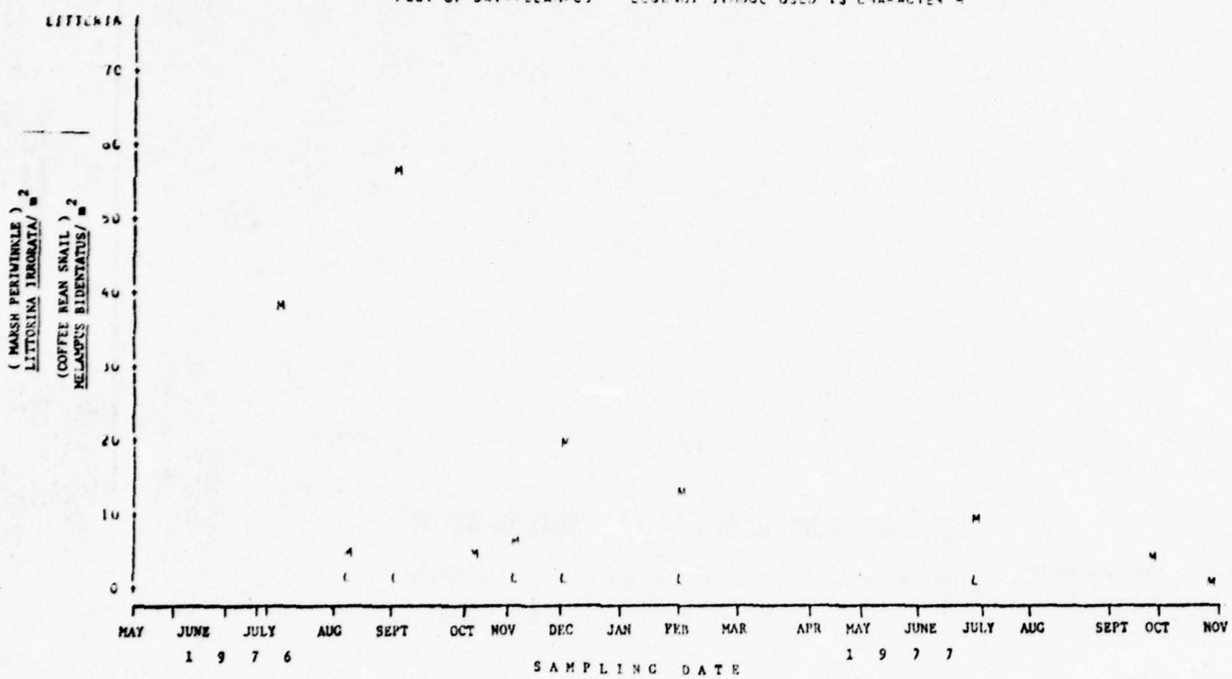
PLOT OF DAY*CRABS   LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS   LEGEND: SYMBOL USED IS CHARACTER B



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING   11:31 TUESDAY, DECEMBER 20, 1977 7

HEIGHT=6

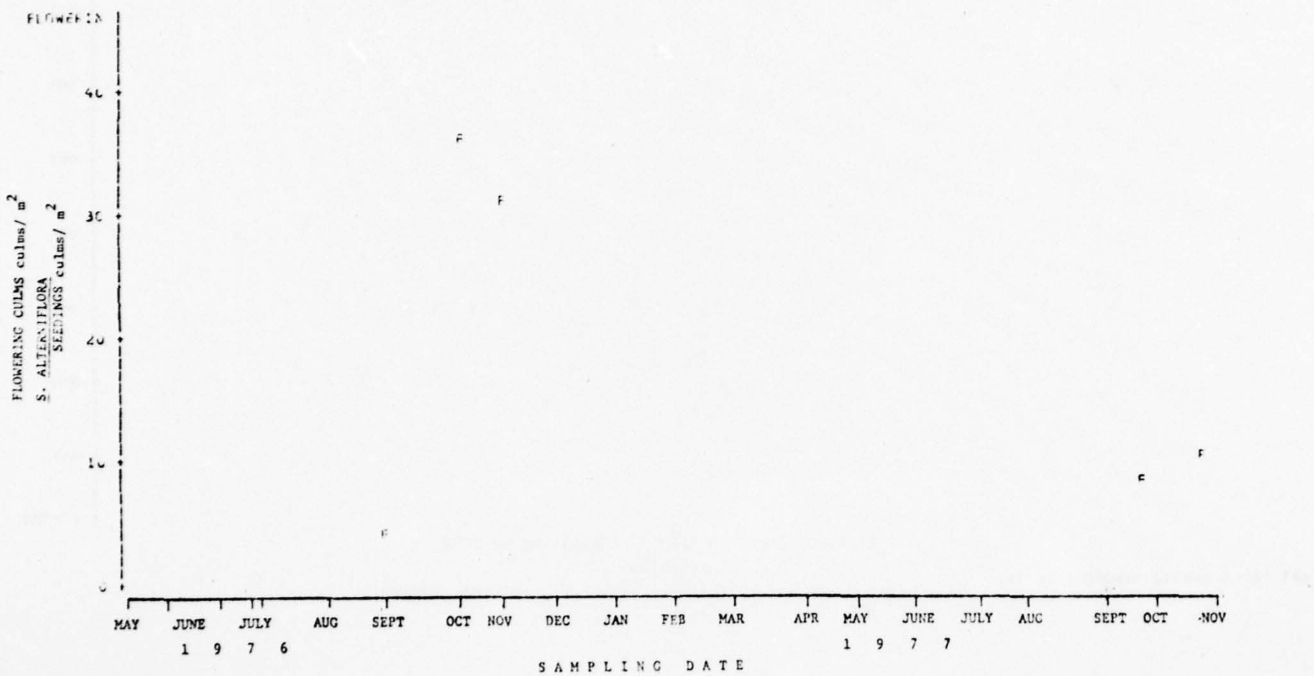
PLOT OF DAY*LITTORIN   LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS   LEGEND: SYMBOL USED IS CHARACTER M



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977 8

HEIGHT=6

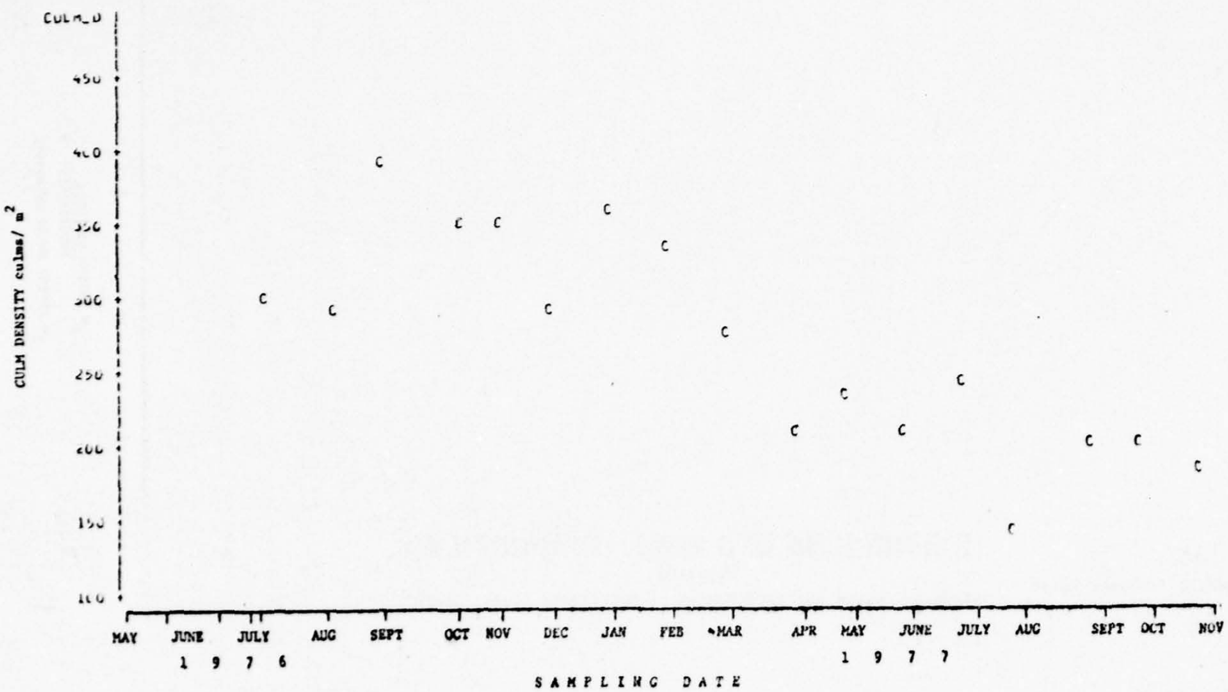
PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977 9

HEIGHT=9

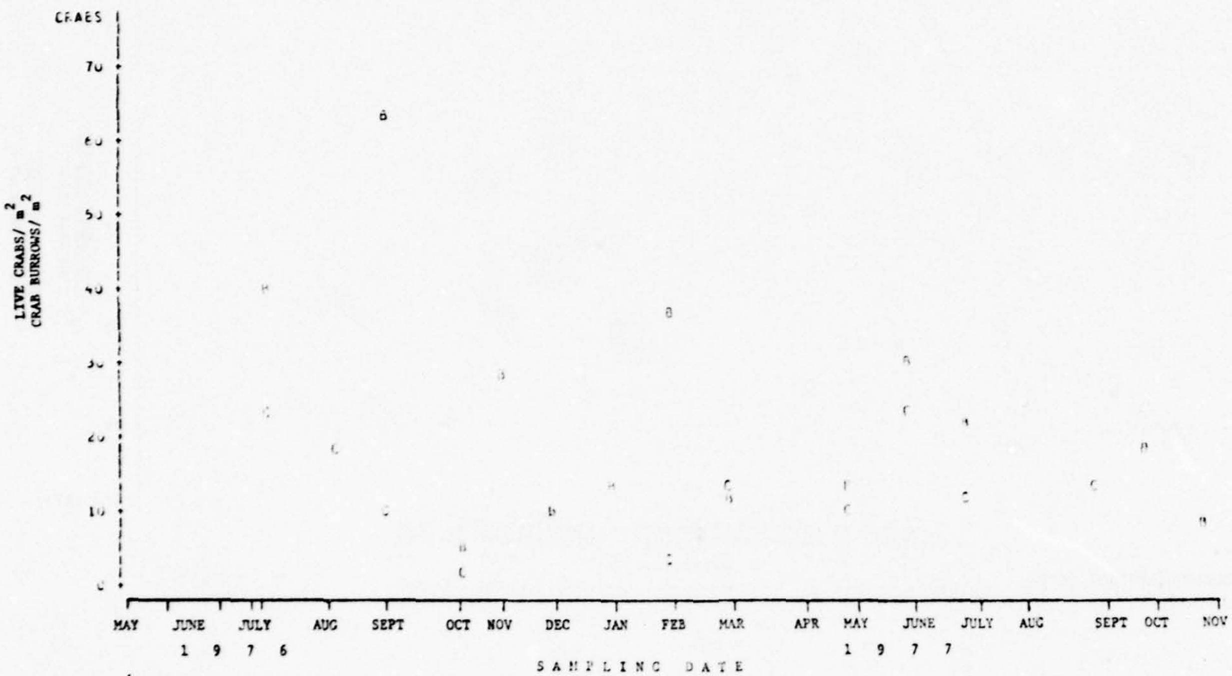
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING   11:31 TUESDAY, DECEMBER 20, 1977   10

HEIGHT=9

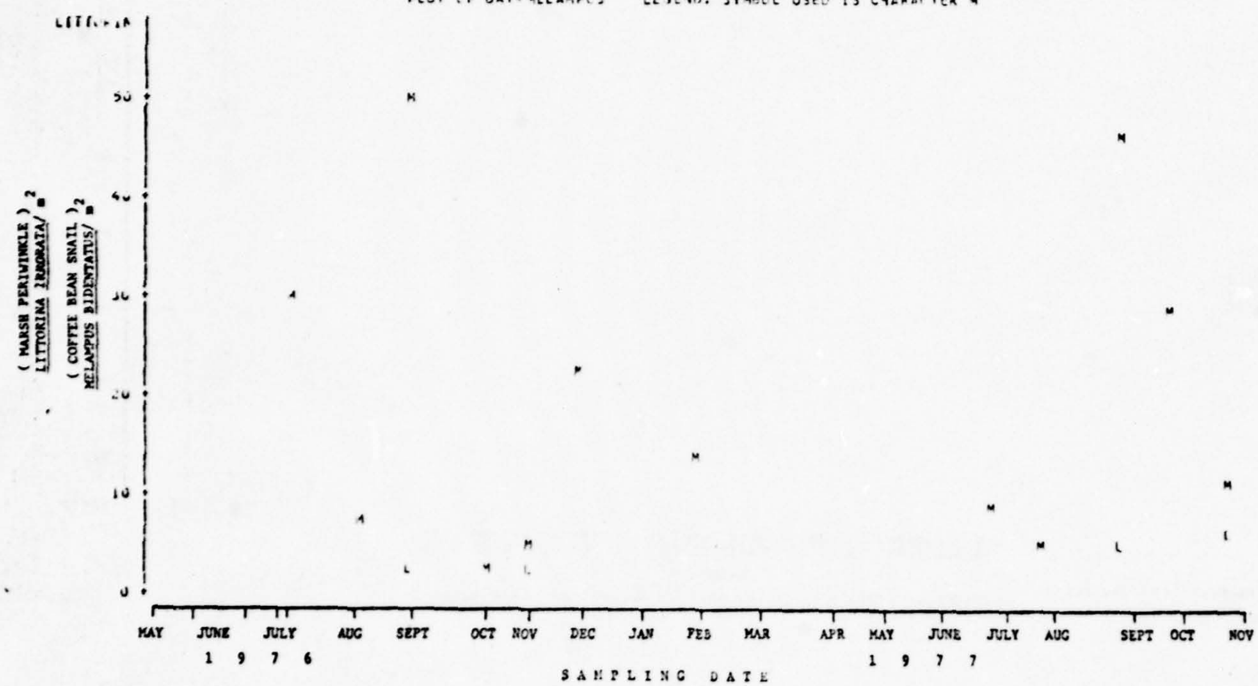
PLOT OF DAY*CRABS   LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS   LEGEND: SYMBOL USED IS CHARACTER B



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING   11:31 TUESDAY, DECEMBER 20, 1977

HEIGHT=9

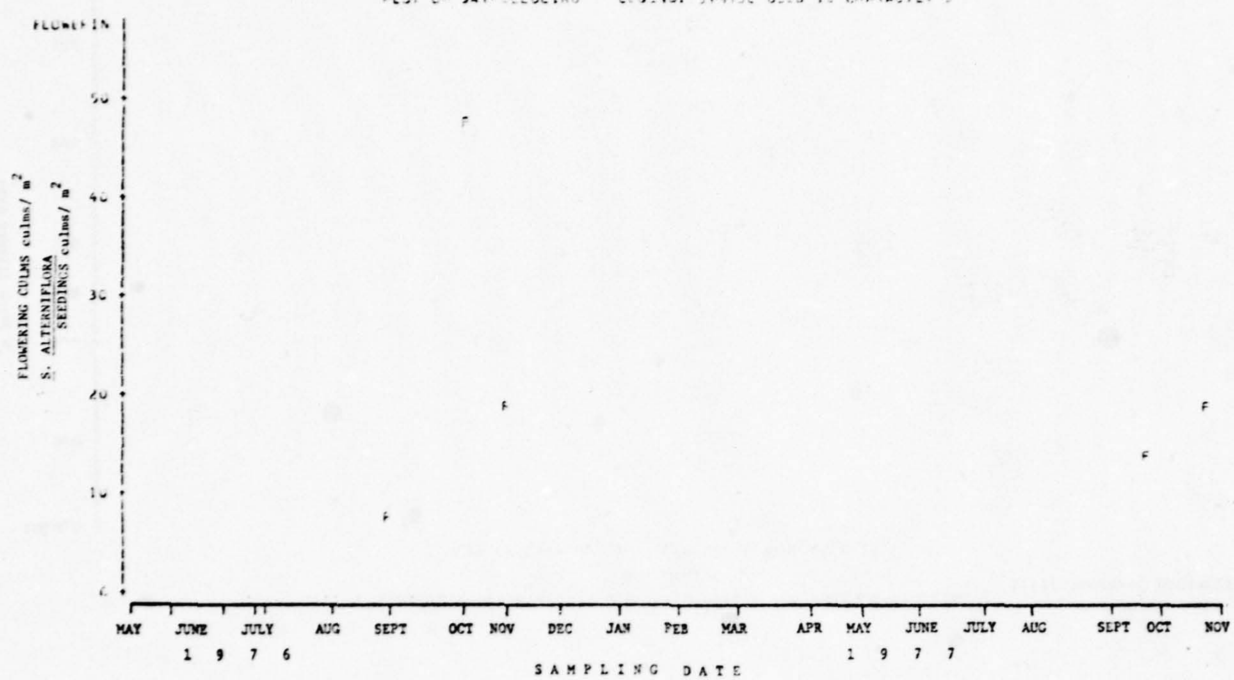
PLOT OF DAY*LITTORIN   LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS   LEGEND: SYMBOL USED IS CHARACTER M



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:21 TUESDAY, DECEMBER 20, 1977 12

HEIGHT=9

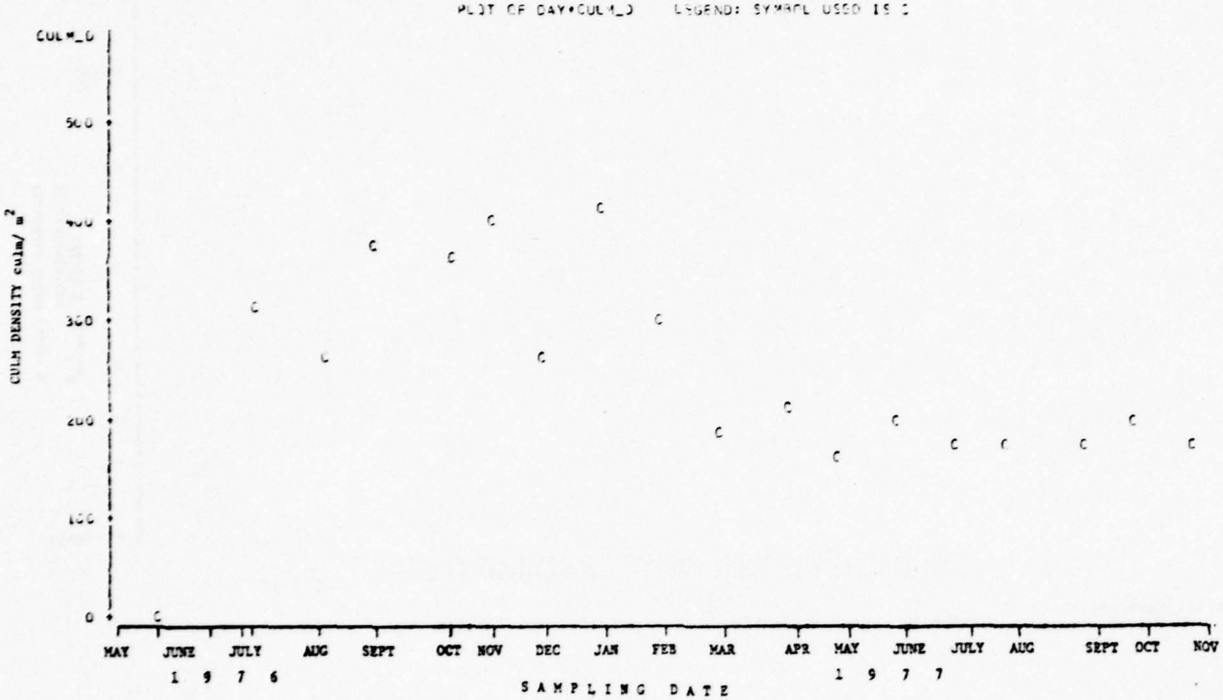
PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977 13

HEIGHT=12

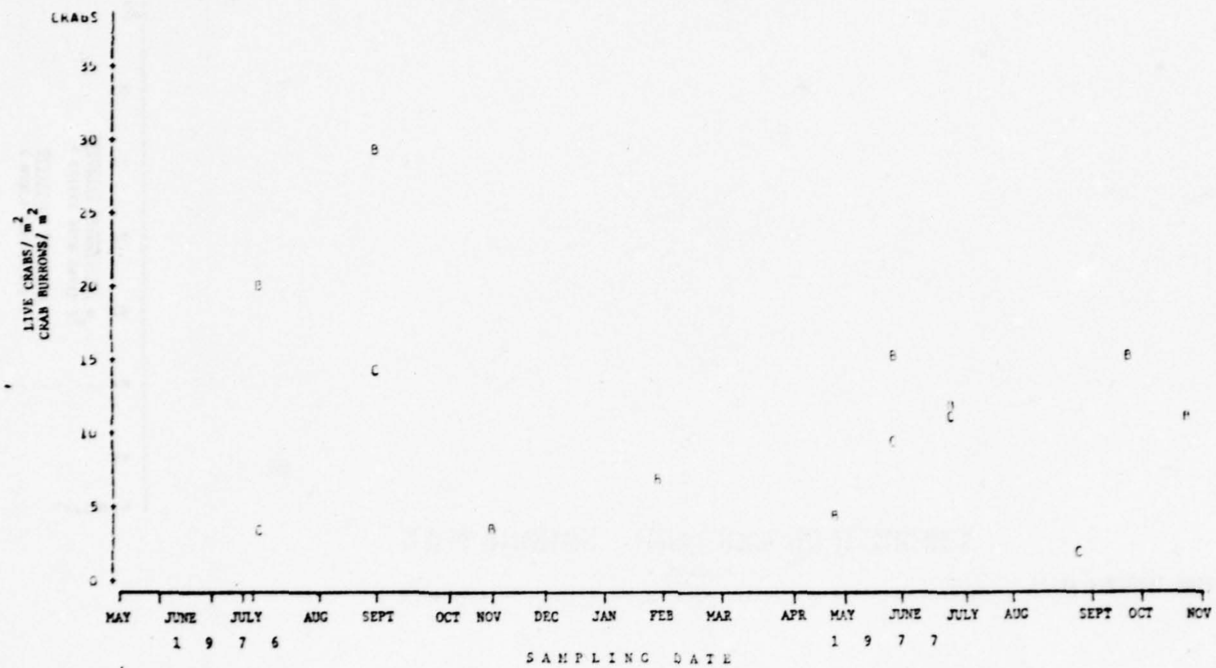
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977 14

HEIGHT=12

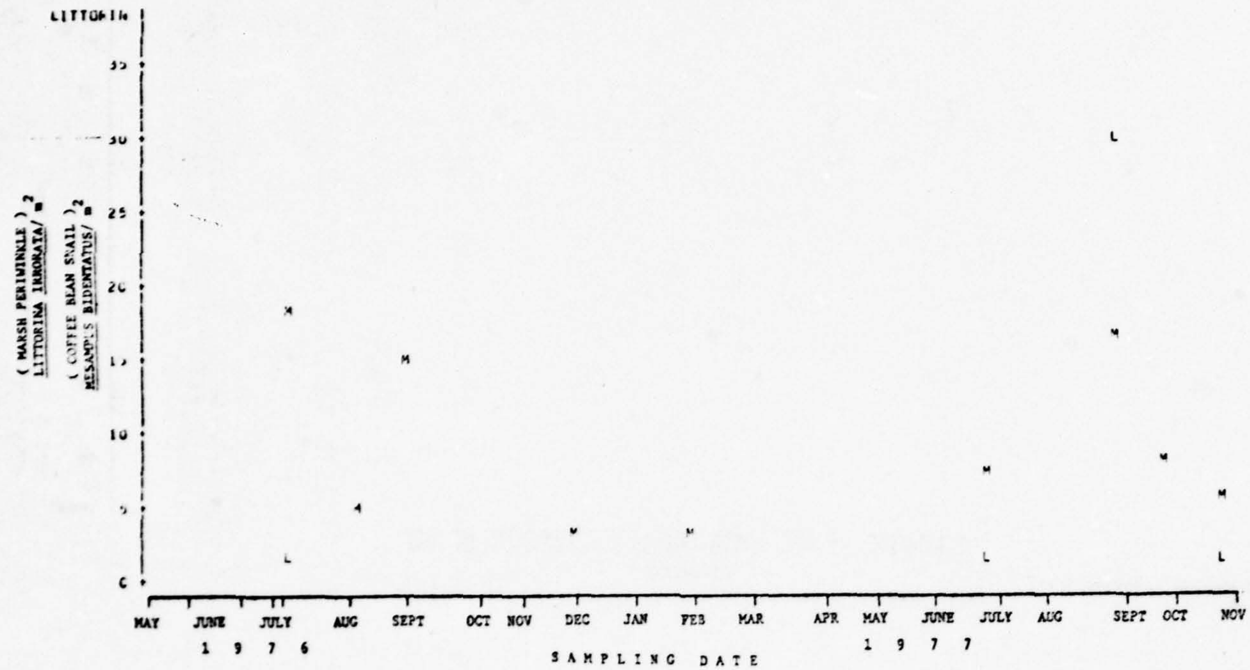
PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977 15

HEIGHT=12

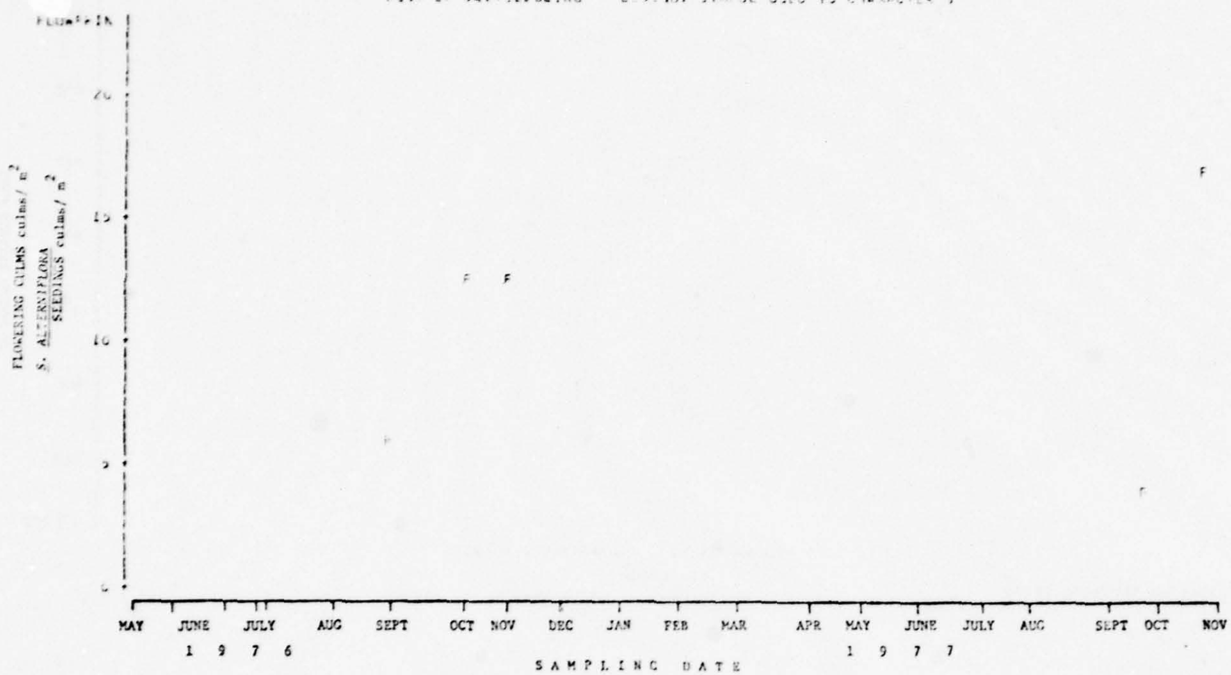
PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING   11:31 TUESDAY, DECEMBER 20, 1977   16

HEIGHT=12

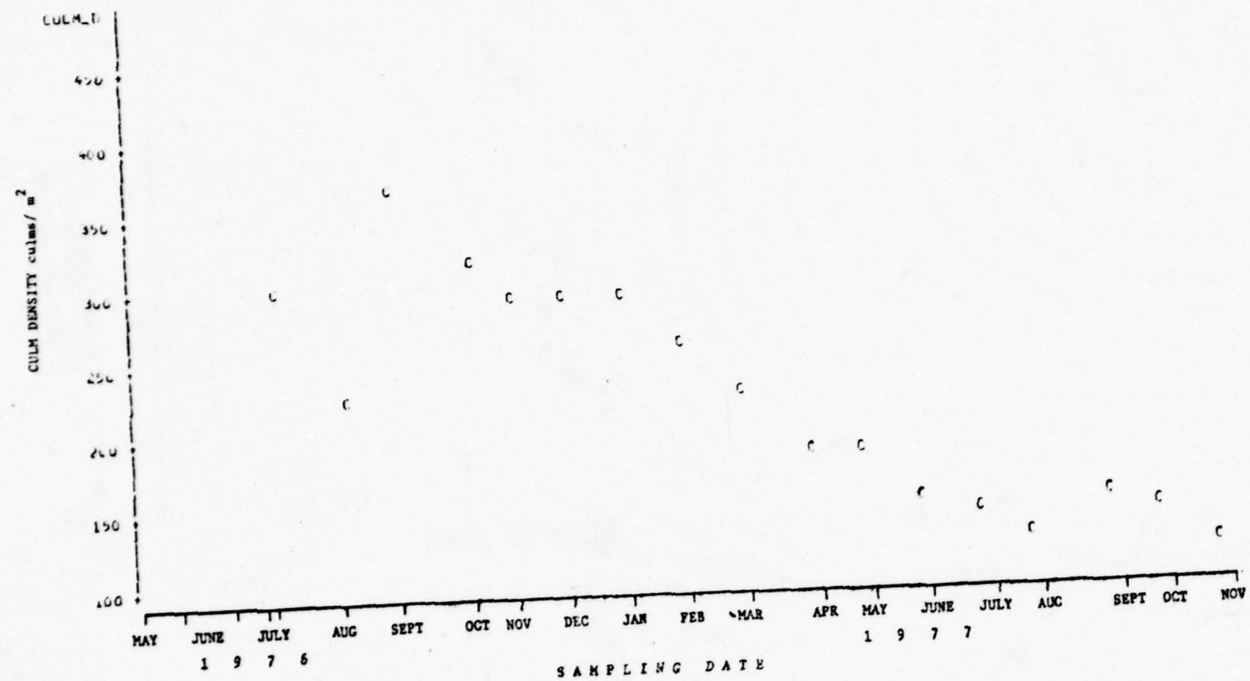
PLOT OF DAY*FLOWERIN   LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING   LEGEND: SYMBOL USED IS CHARACTER S



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977 17

HEIGHT=24

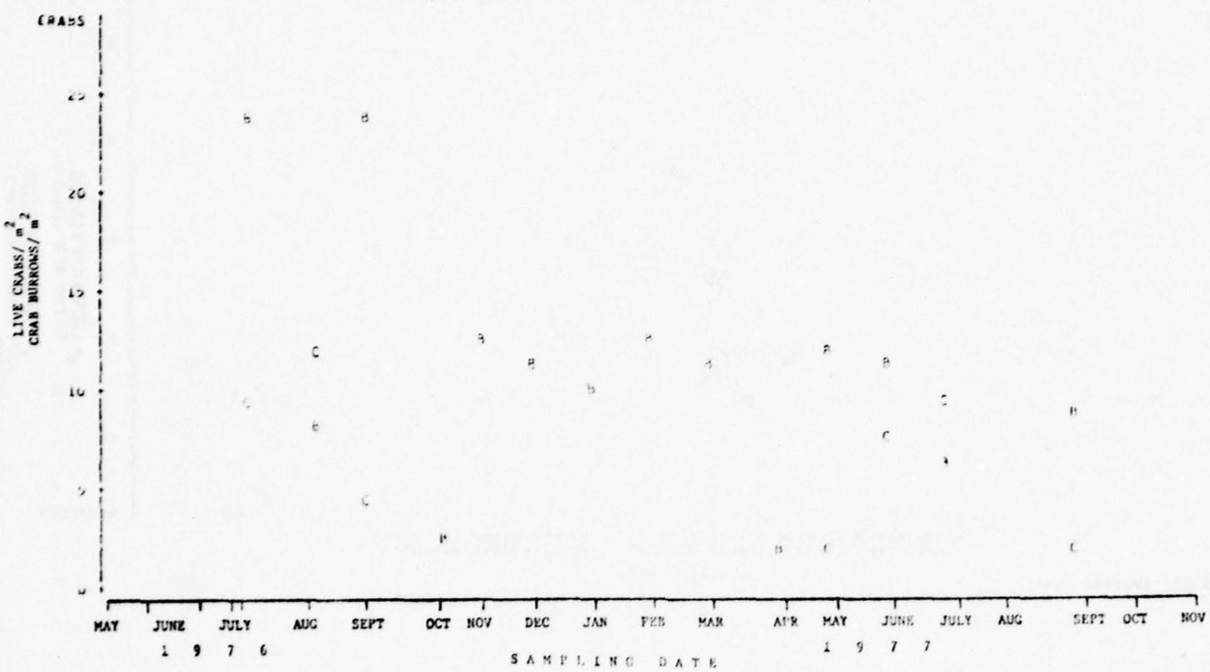
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977 18

HEIGHT=24

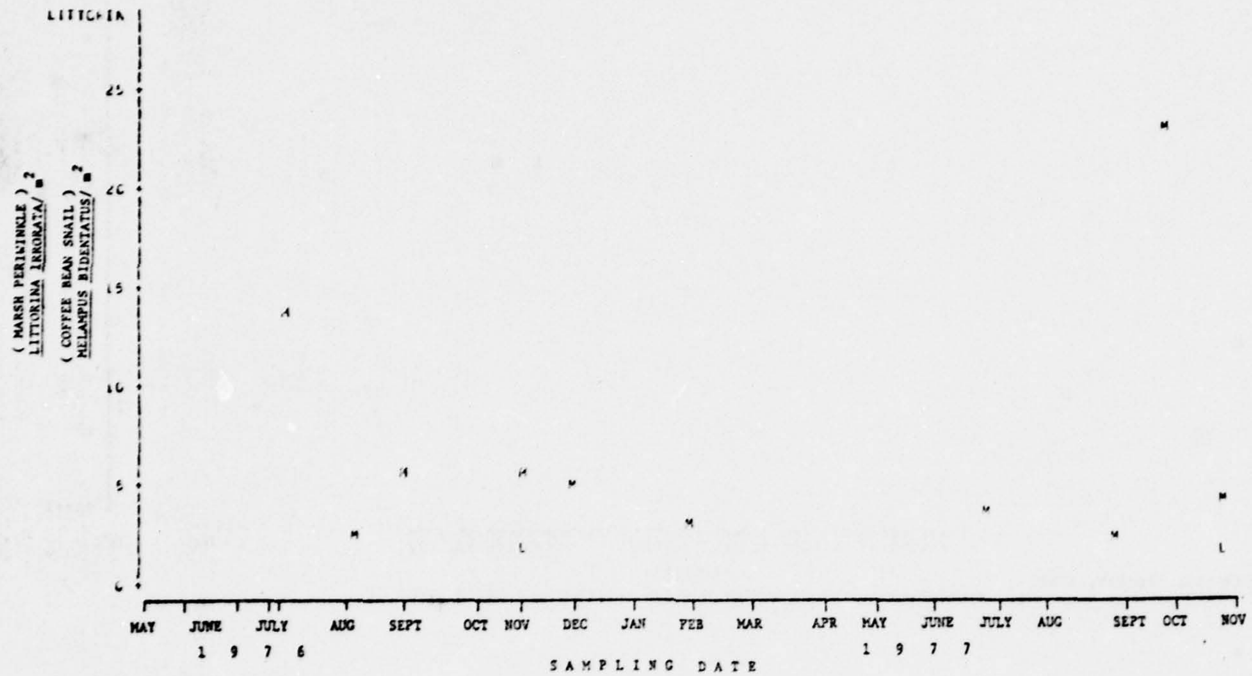
PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977 19

HEIGHT=24

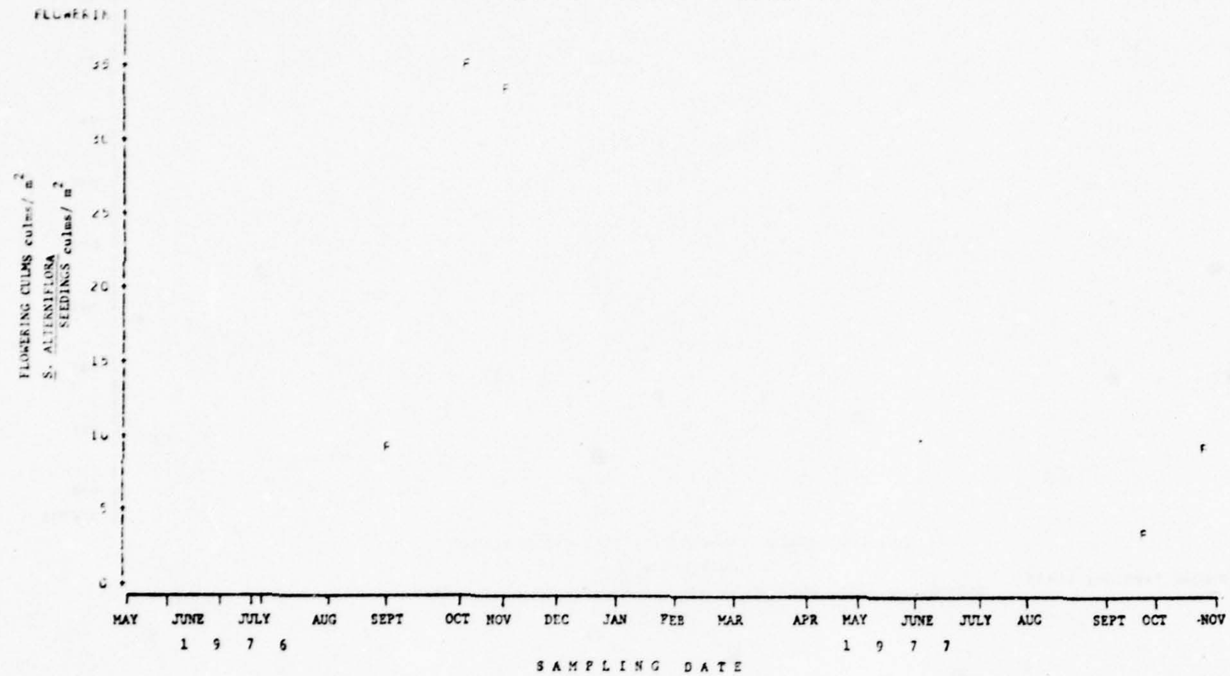
PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING   11:31 TUESDAY, DECEMBER 20, 1977 20

HEIGHT=24

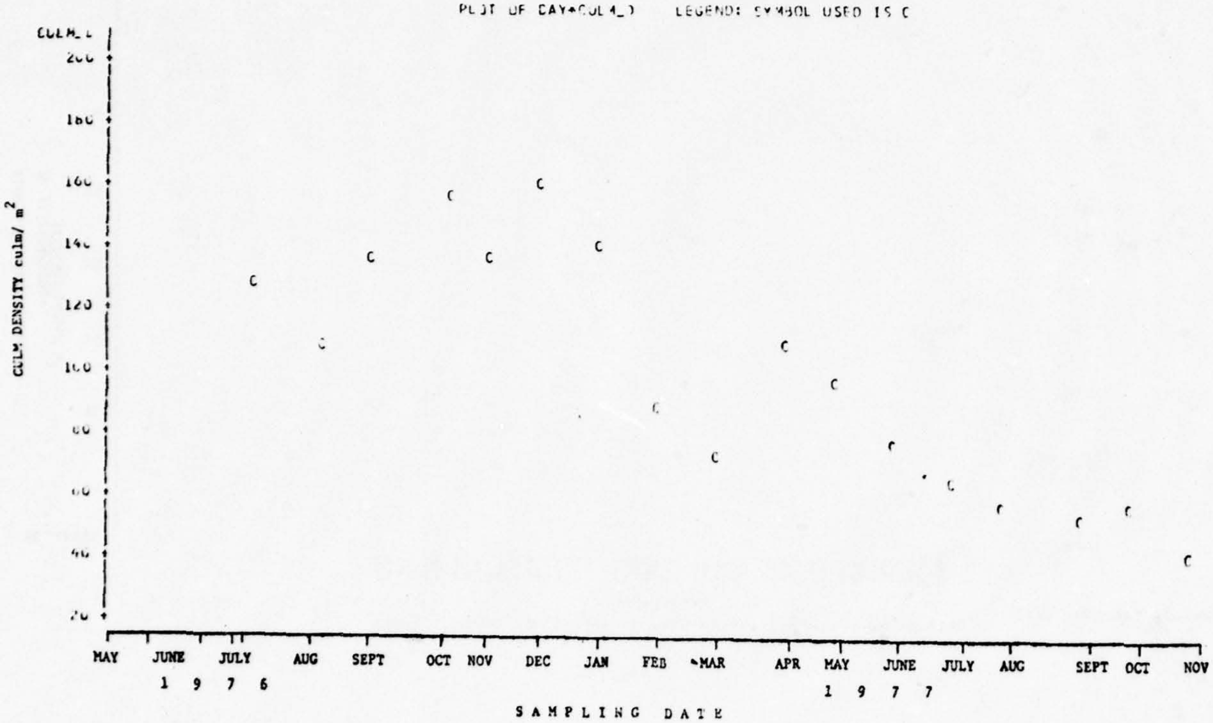
PLOT OF DAY*FLOWERIN   LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING   LEGEND: SYMBOL USED IS CHARACTER S



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977 21

HEIGHT=36

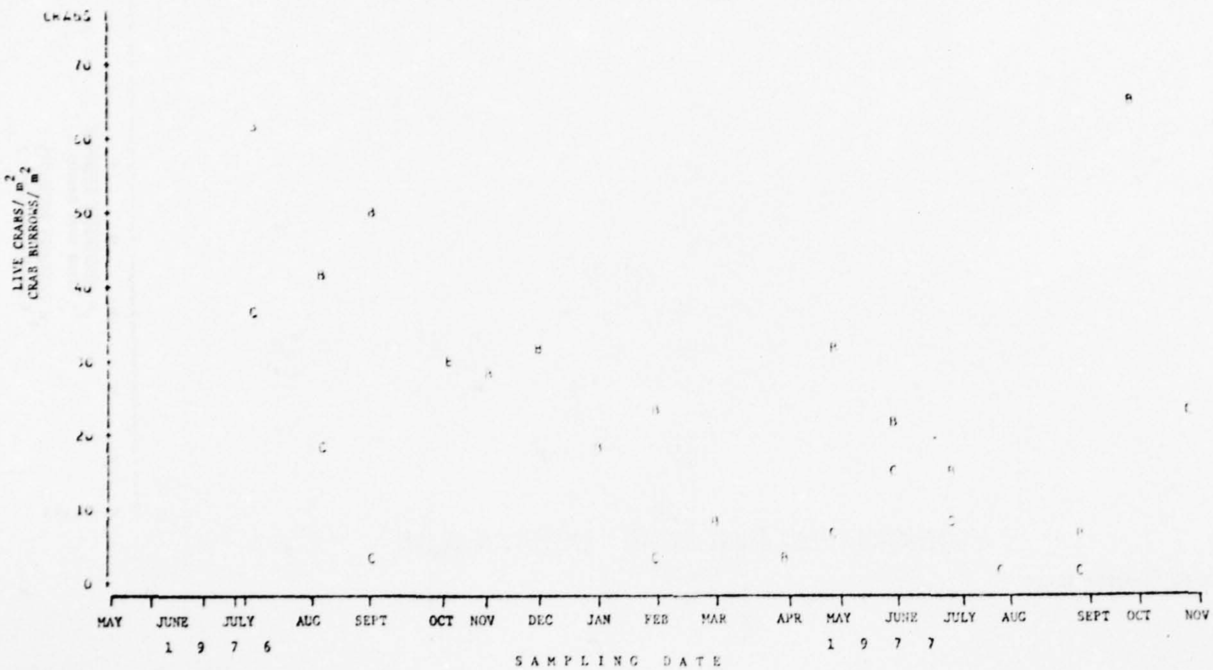
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977 22

HEIGHT=36

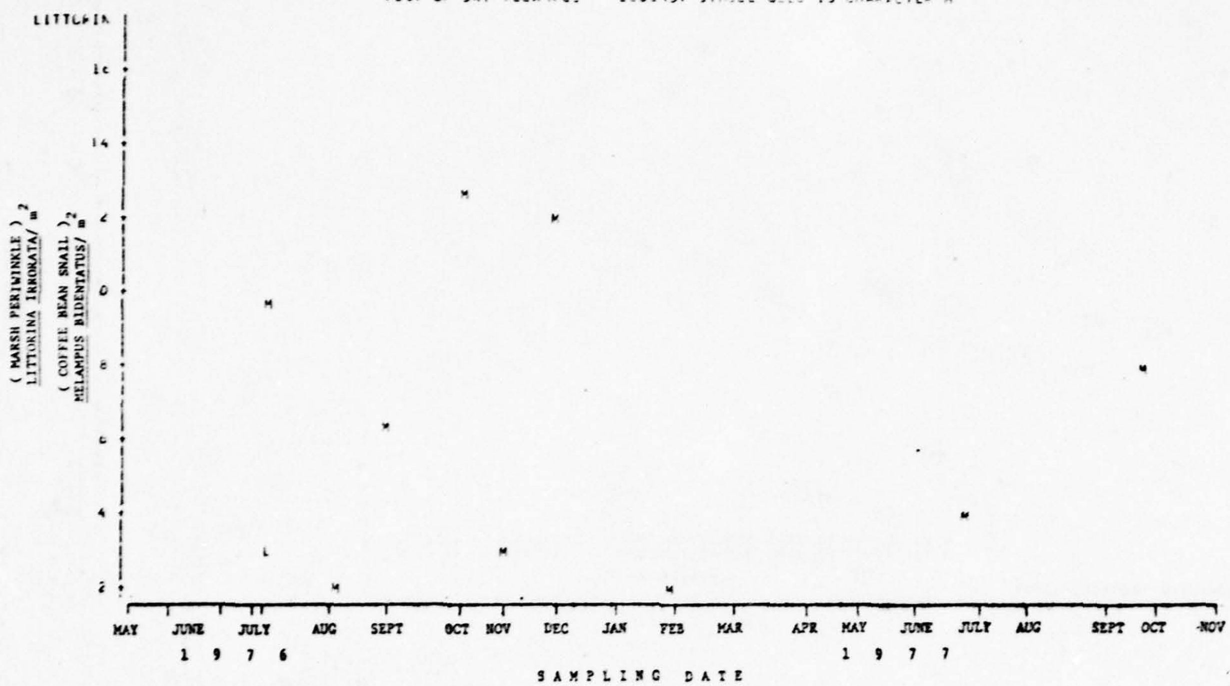
PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 23
11:31 TUESDAY, DECEMBER 20, 1977

HEIGHT=36

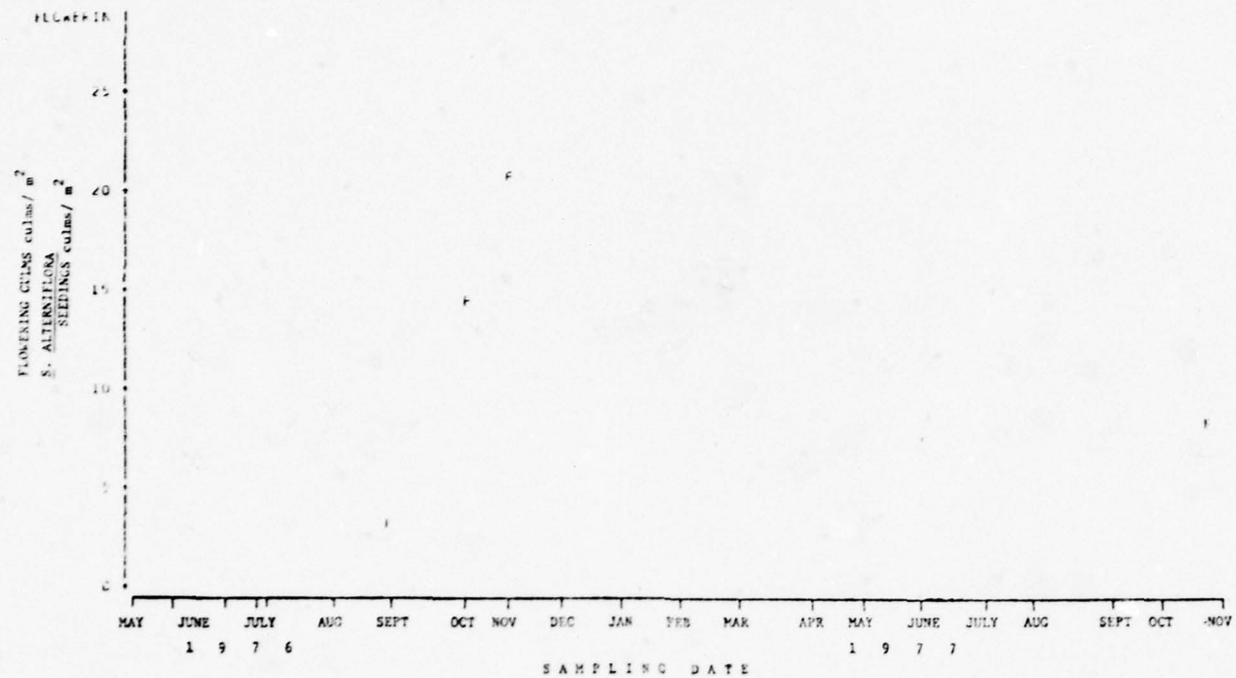
PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



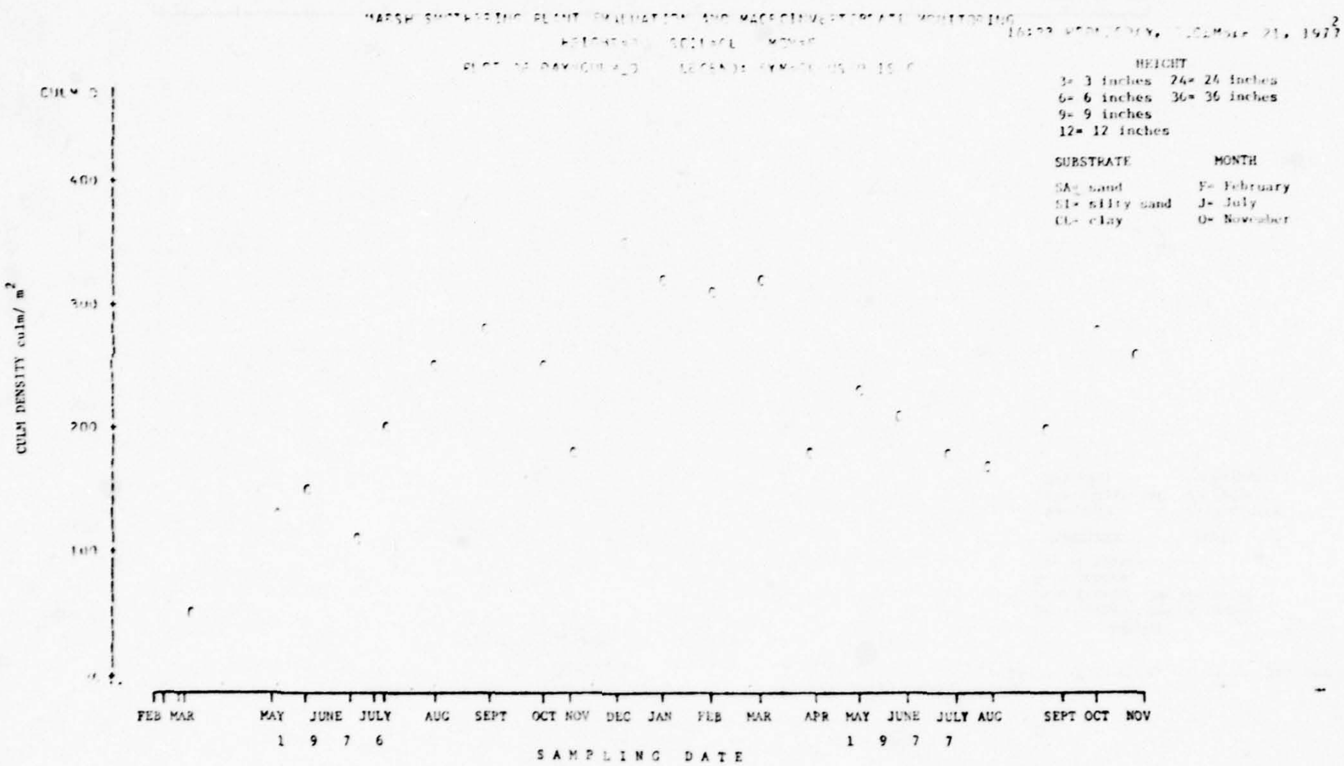
CONTROL PIPES EVALUATION AT EACH HEIGHT FOR MARSH SMOTHERING 11:31 TUESDAY, DECEMBER 20, 1977 24

HEIGHT=36

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



PART 3

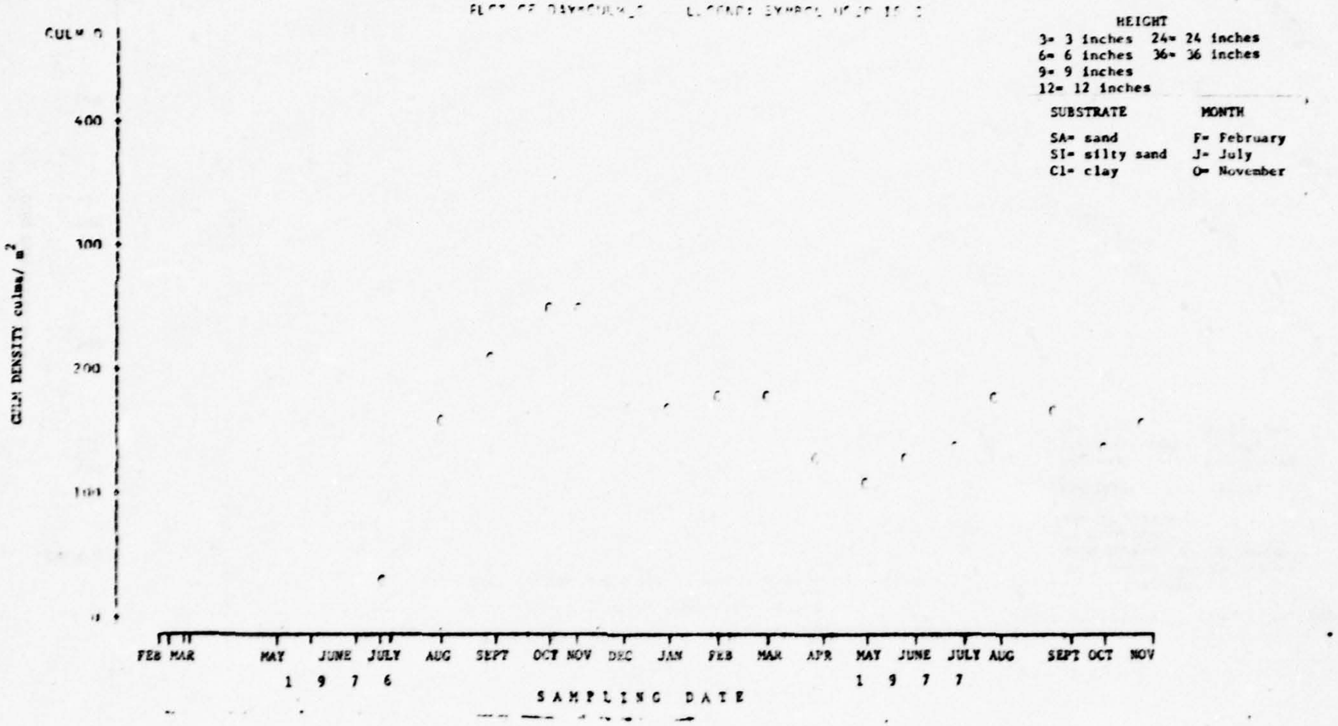

HEIGHT
3= 3 inches 24= 24 inches
6= 6 inches 36= 36 inches
9= 9 inches
12= 12 inches
SUBSTRATE
SA= sand
SI= silty sand
CL= clay
MONTH
F= February
J= July
O= November
CULM DENSITY culm/ m2
400
300
200
100
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING

16:22 WEDNESDAY, DECEMBER 21, 1977 3

HEIGHT=[illegible] SOIL=CL MON=J

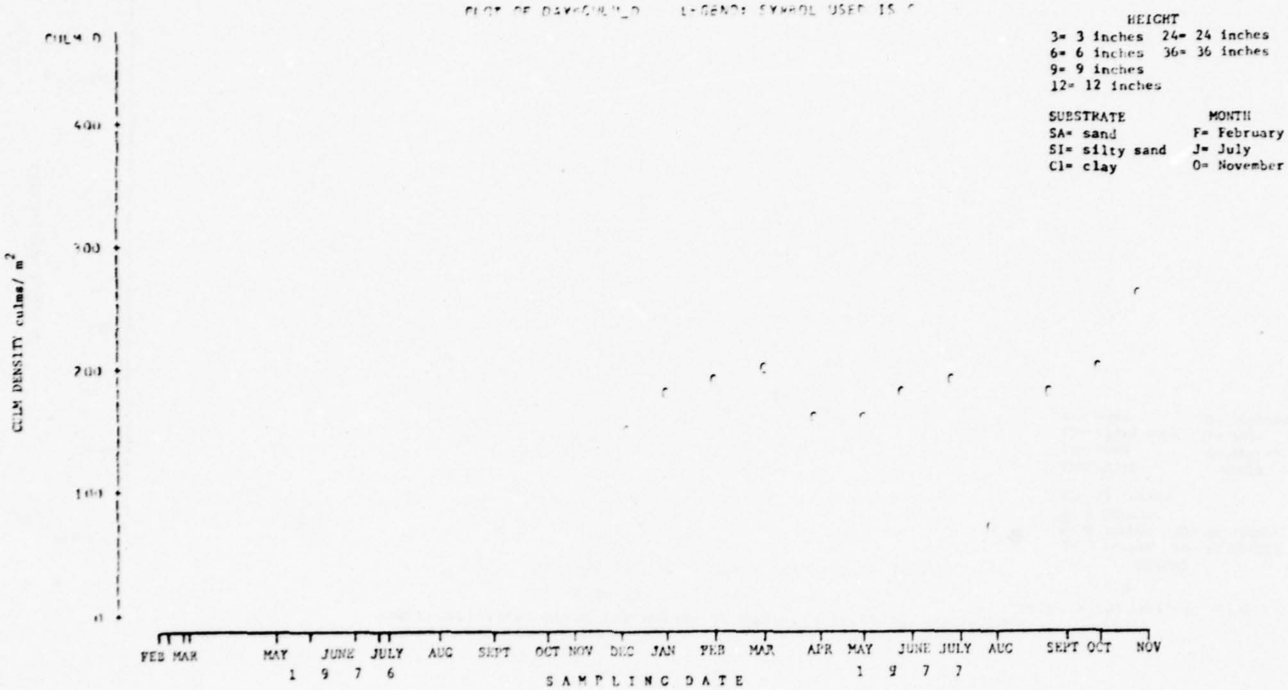
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



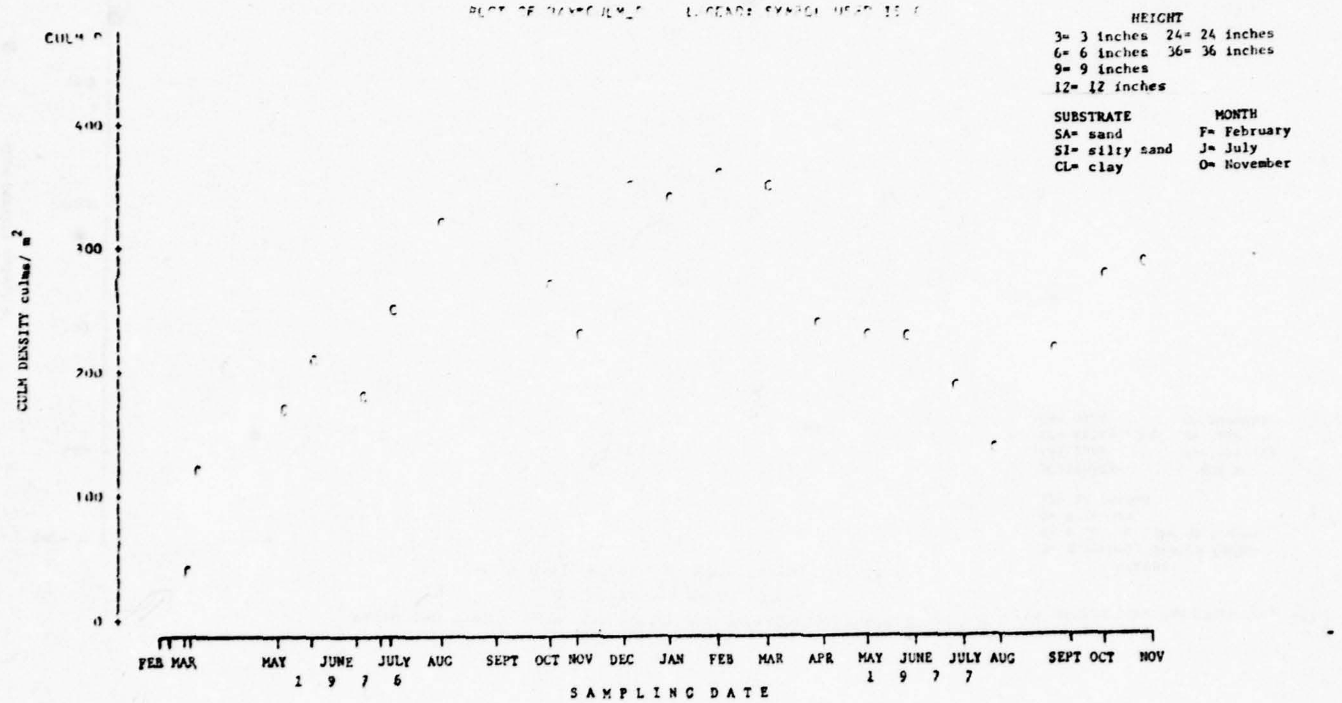
MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:33 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=3   SOIL=CL   MON=O

PLOT OF DAY*CULM_D   LEGEND: SYMBOL USED IS C



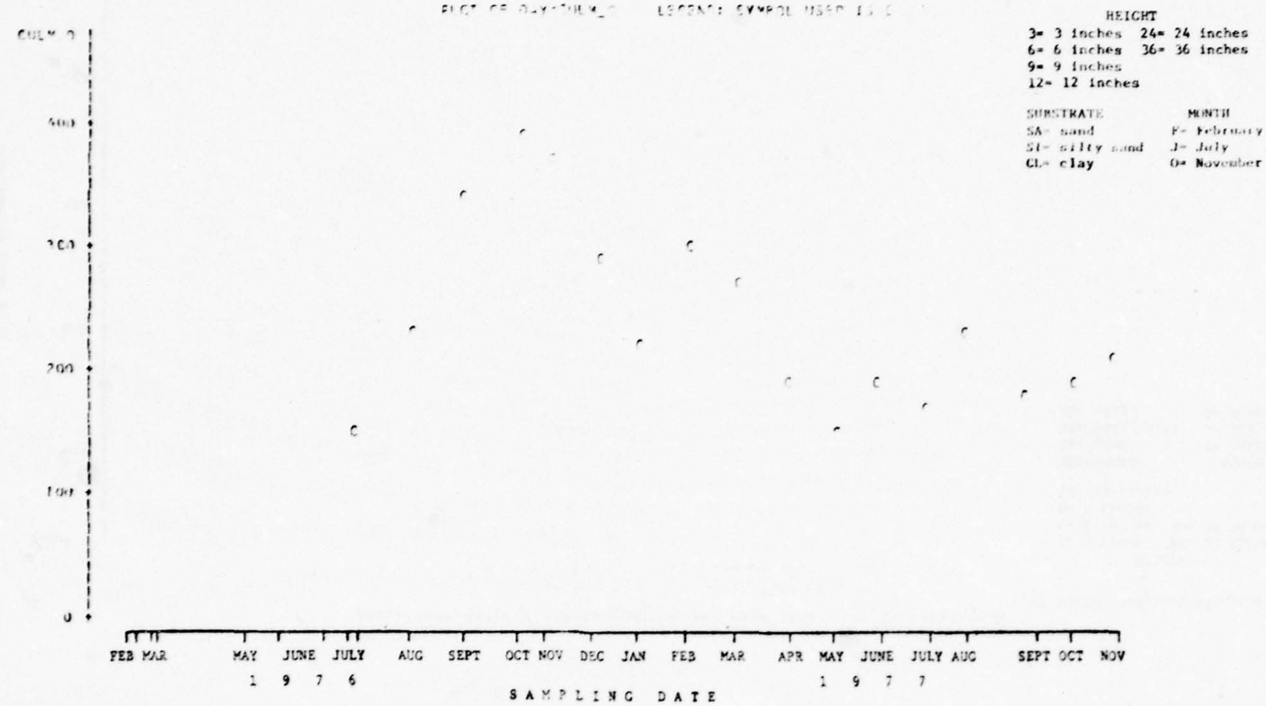
MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 5



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 6

HEIGHT=3 SOIL=SA MON=J

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 7

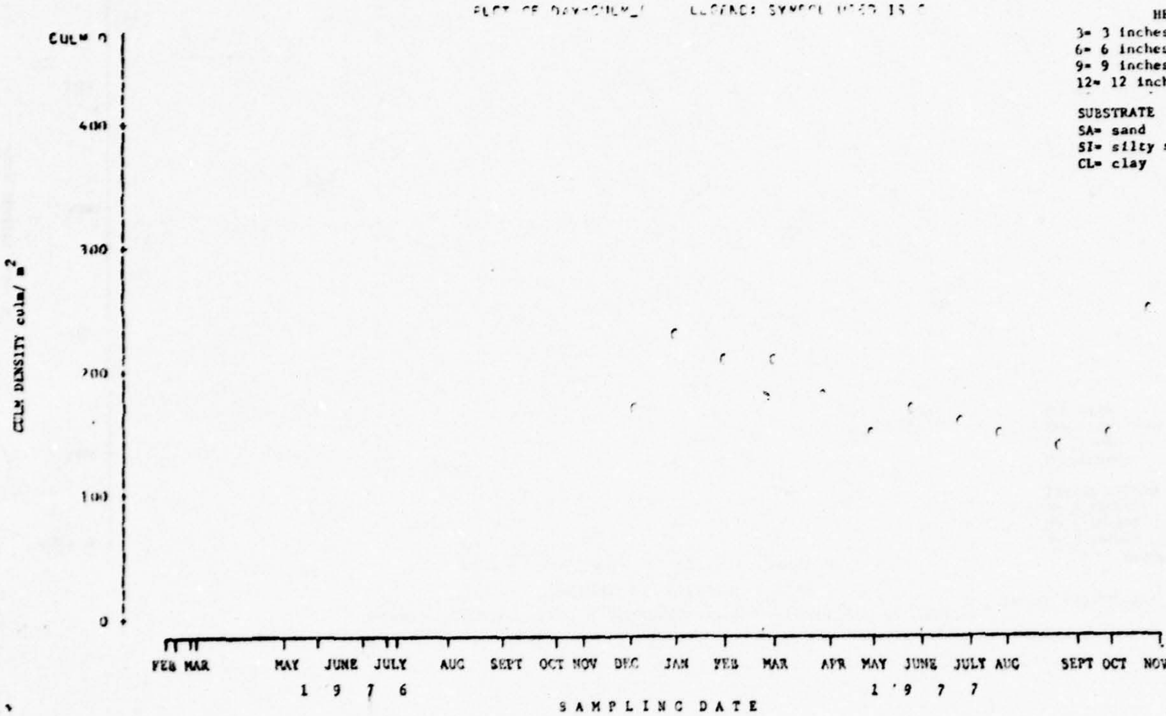
HEIGHT=3 SOIL=SA MO=?

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C

HEIGHT
3= 3 inches 24= 24 inches
6= 6 inches 36= 36 inches
9= 9 inches
12= 12 inches

SUBSTRATE
SA= sand
SI= silty sand
CL= clay

MONTH
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 8

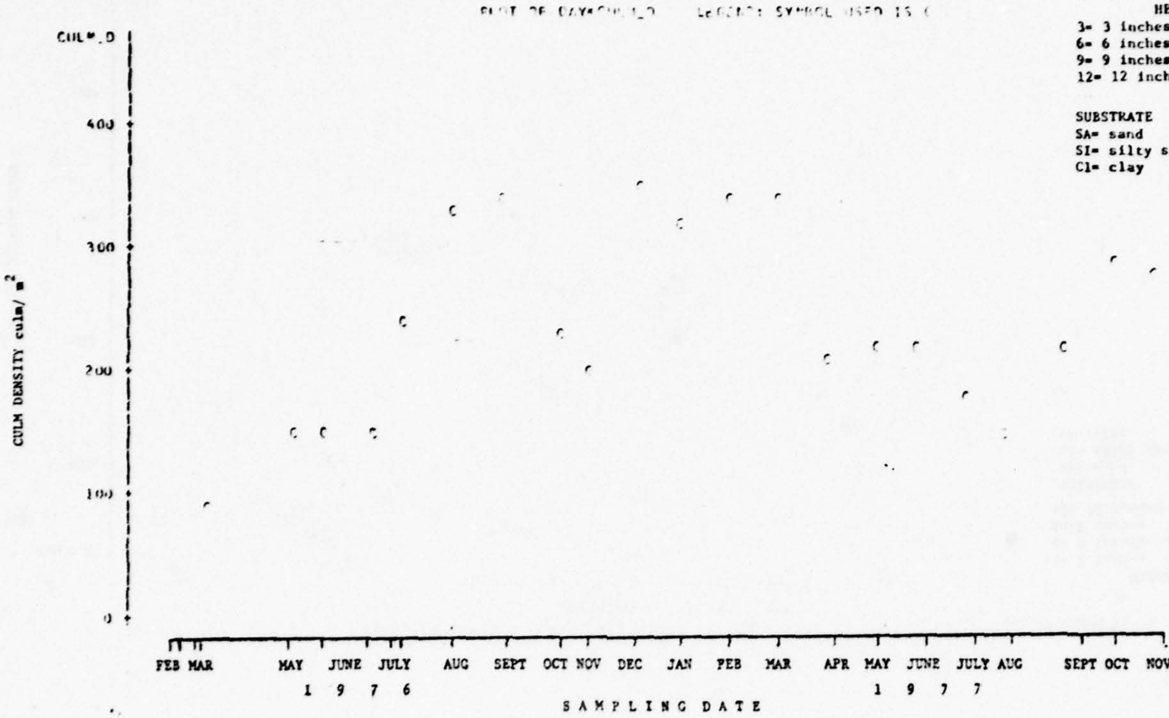
HEIGHT=3 SOIL=SI MON=F

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C

HEIGHT
3= 3 inches 24= 24 inches
6= 6 inches 36= 36 inches
9= 9 inches
12= 12 inches

SUBSTRATE
SA= sand
SI= silty sand
Cl= clay

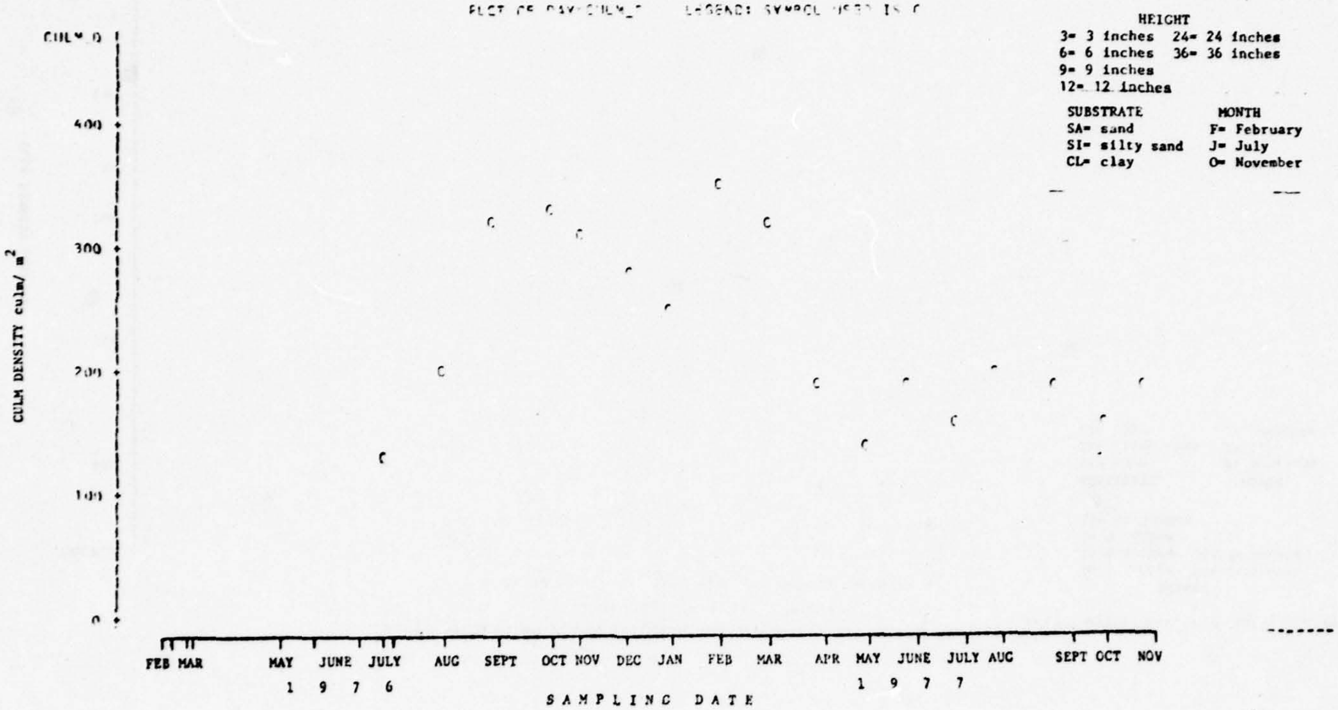
MONTH
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVESTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 9

HEIGHT=3 SOIL=SI MON=J

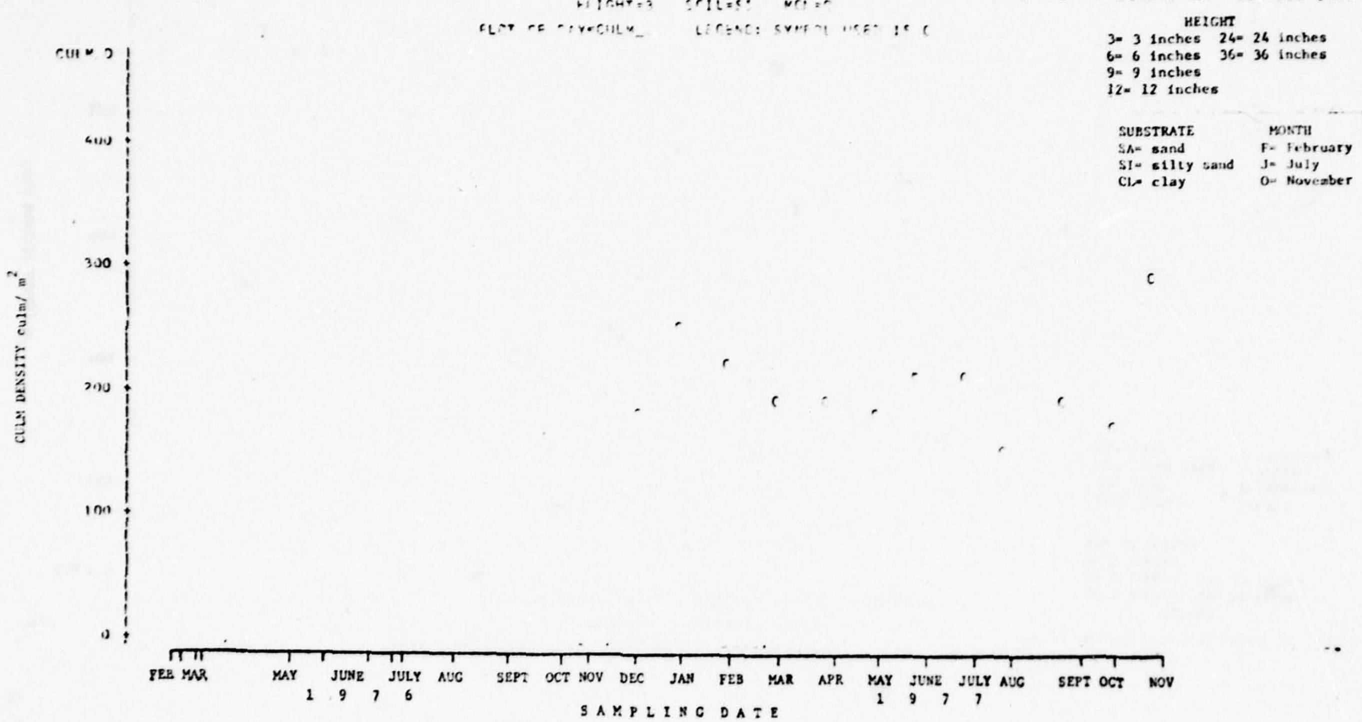
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 10

HEIGHT=3 SOIL=SI MO=O

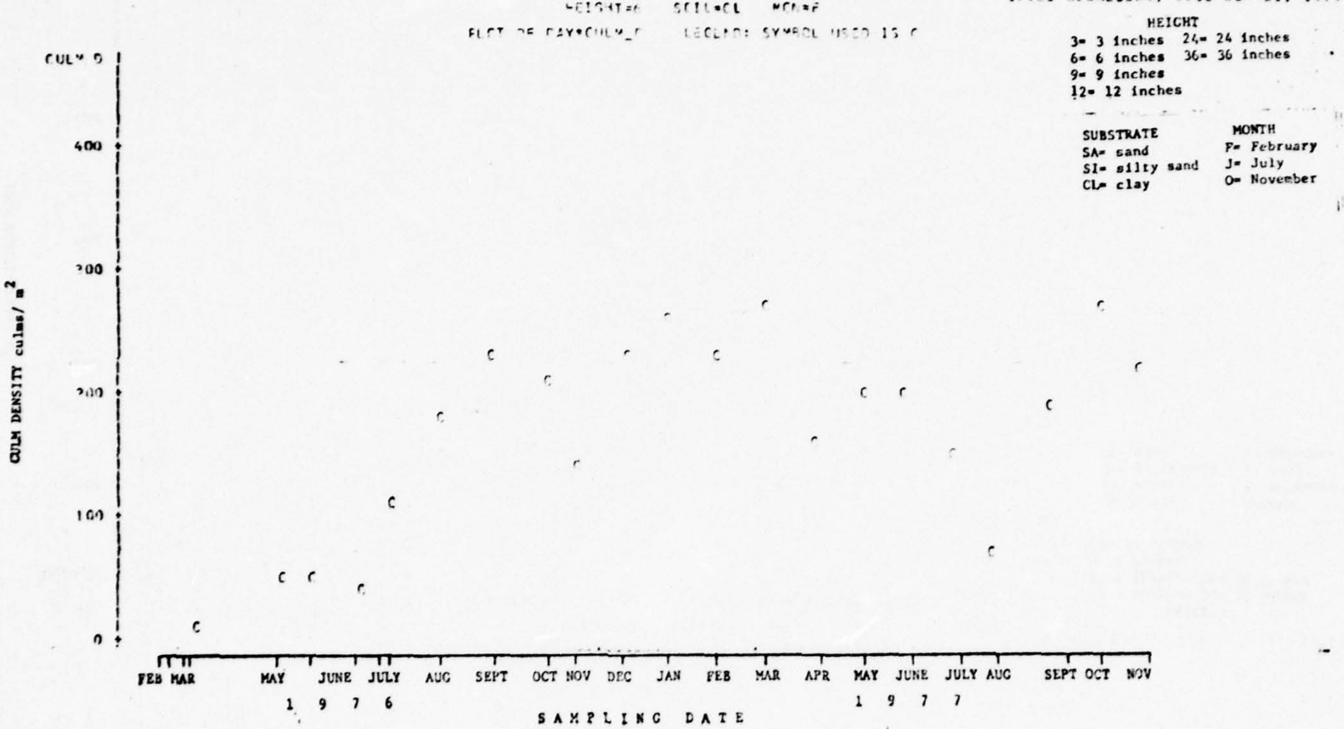
PLOT OF DAY*CULM_ LEGEND: SYMBOL USED IS C



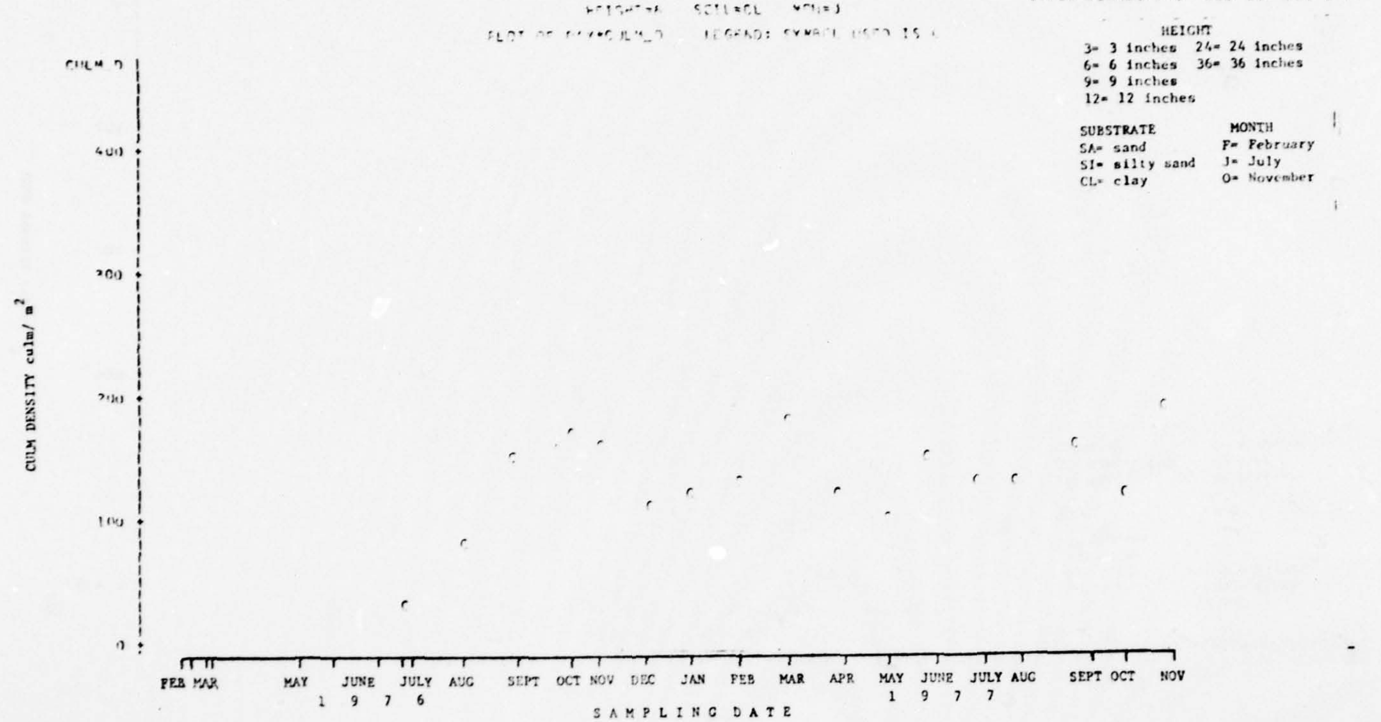
MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 11
14:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=6 SOIL=CL MON=F

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C

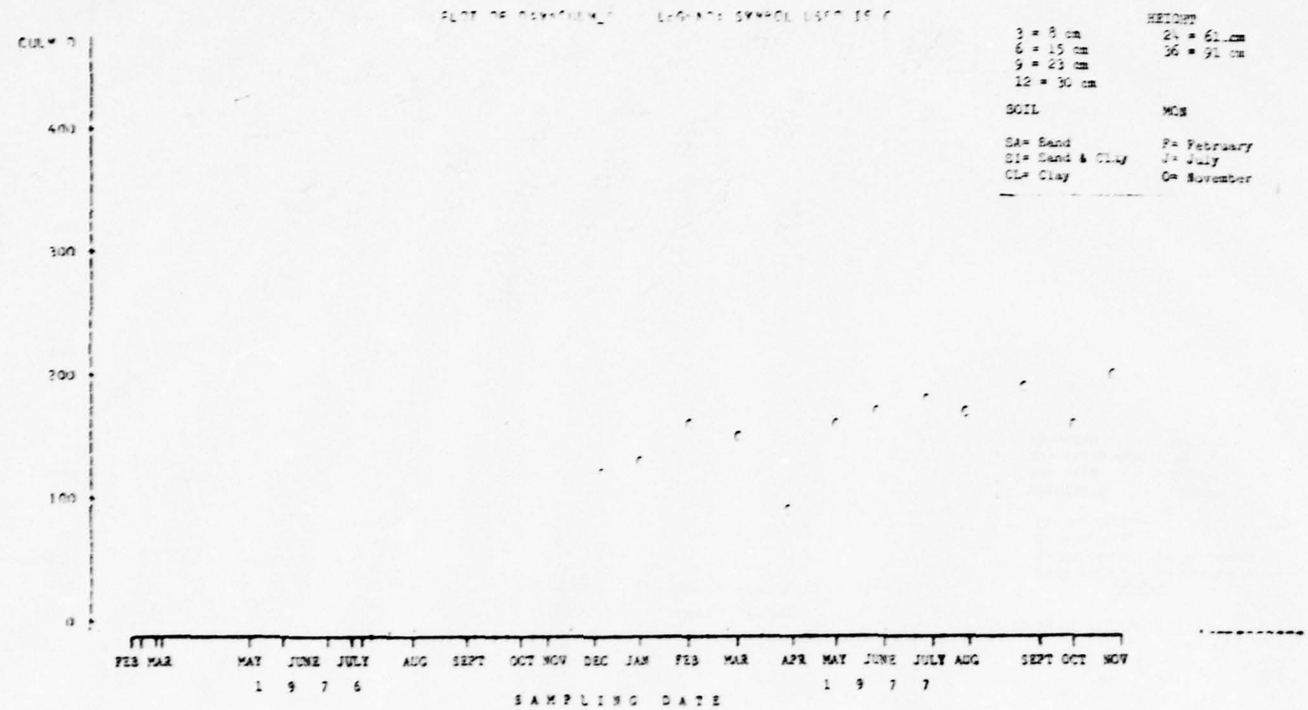


MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 12



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 13

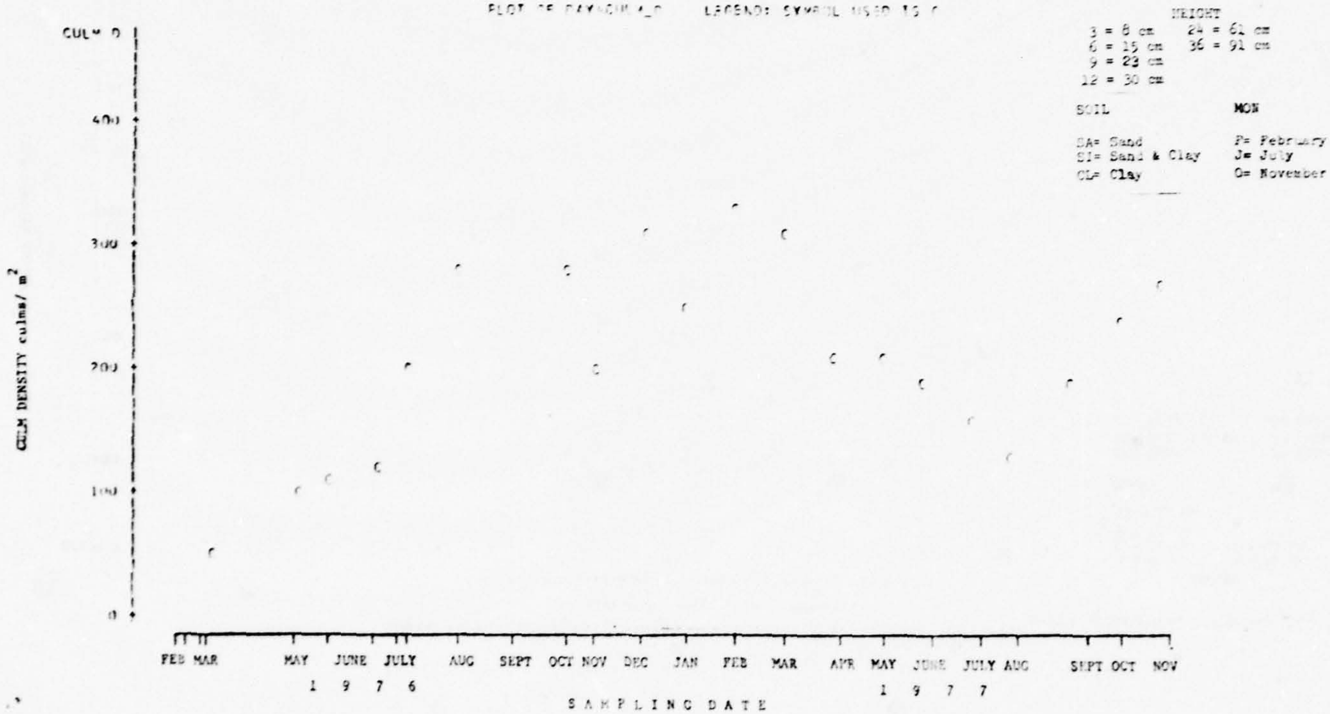
SOIL=CL



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 14

HEIGHT=6 SOIL=SA MON=F

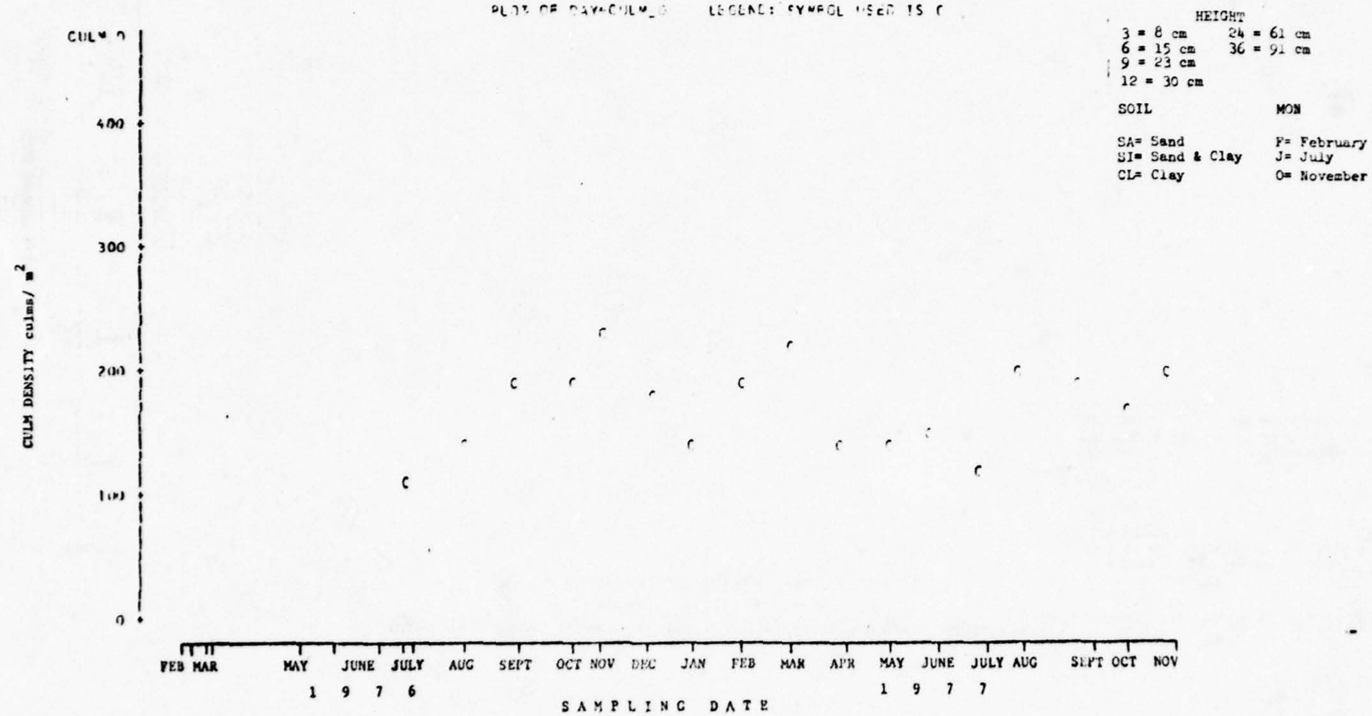
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



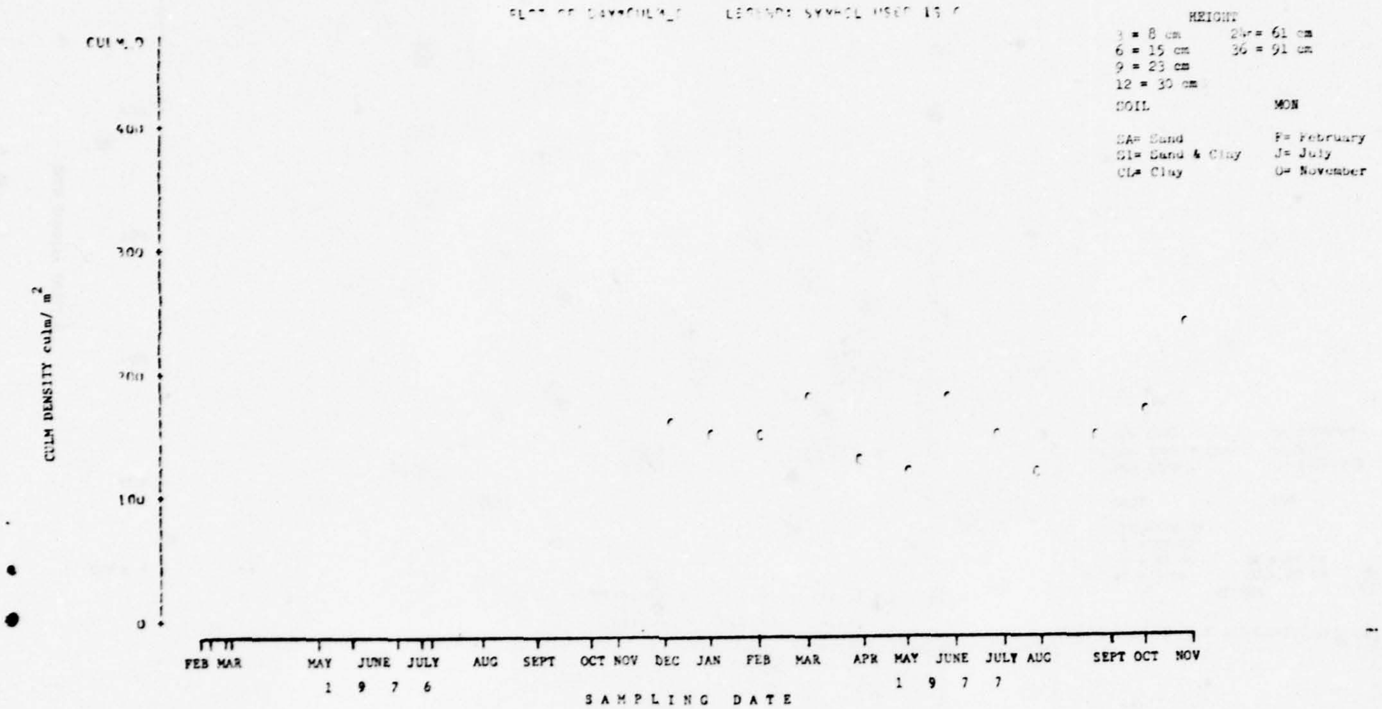
MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 15

HEIGHT=/ SOIL=SA MON=J

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 16

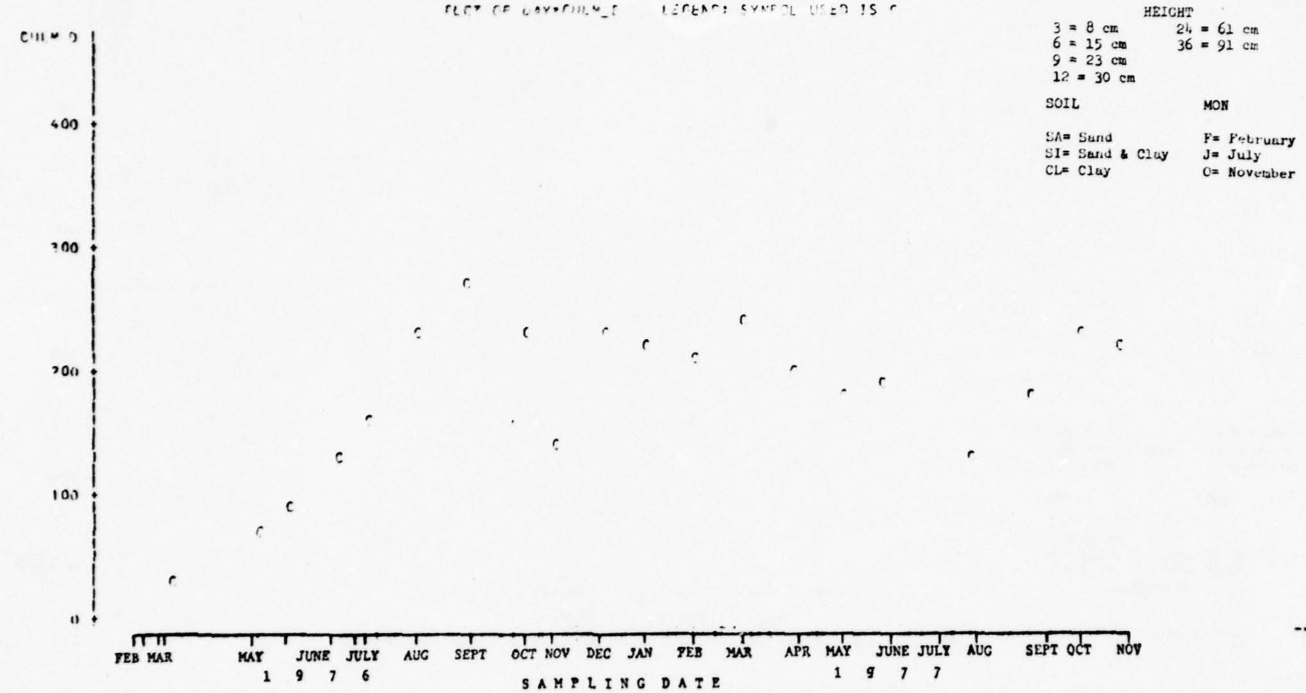


17

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=A SOIL=SI MON=F

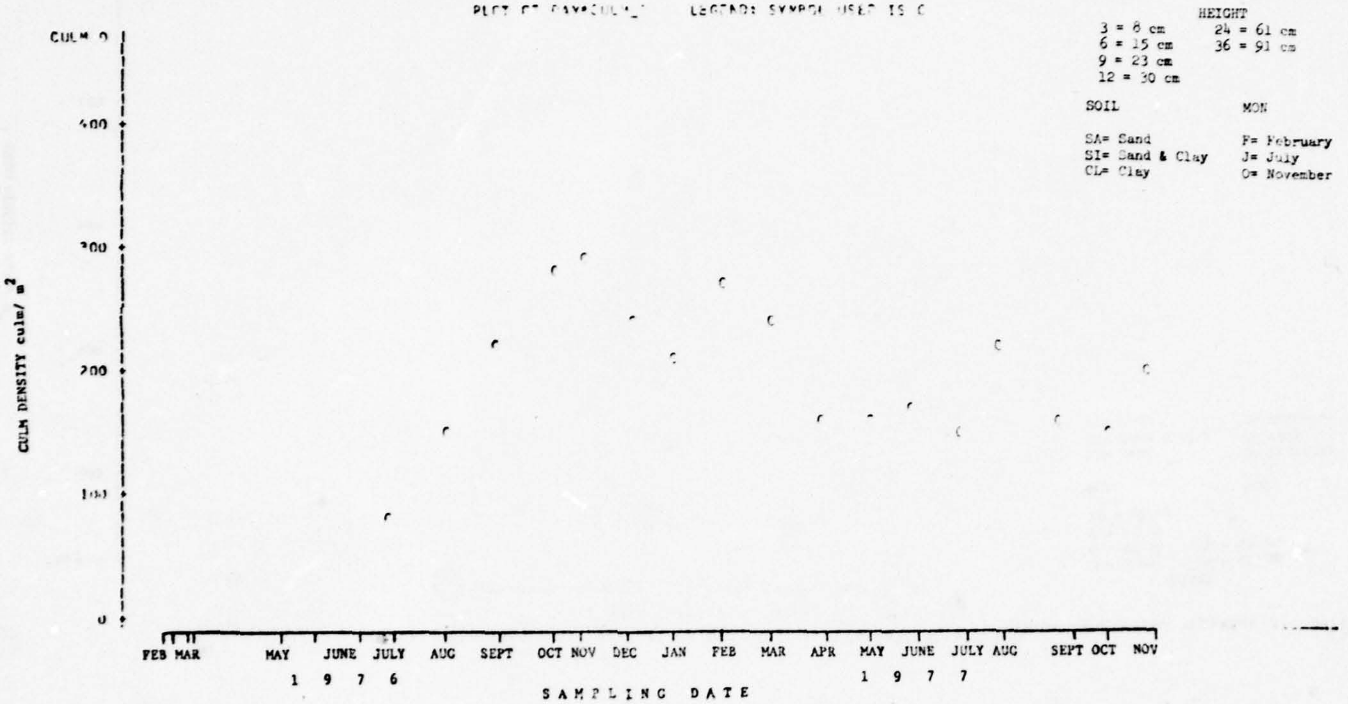
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:?? WEDNESDAY, DECEMBER 21, 1977 18

HEIGHT=6 SOIL=SI MON=J

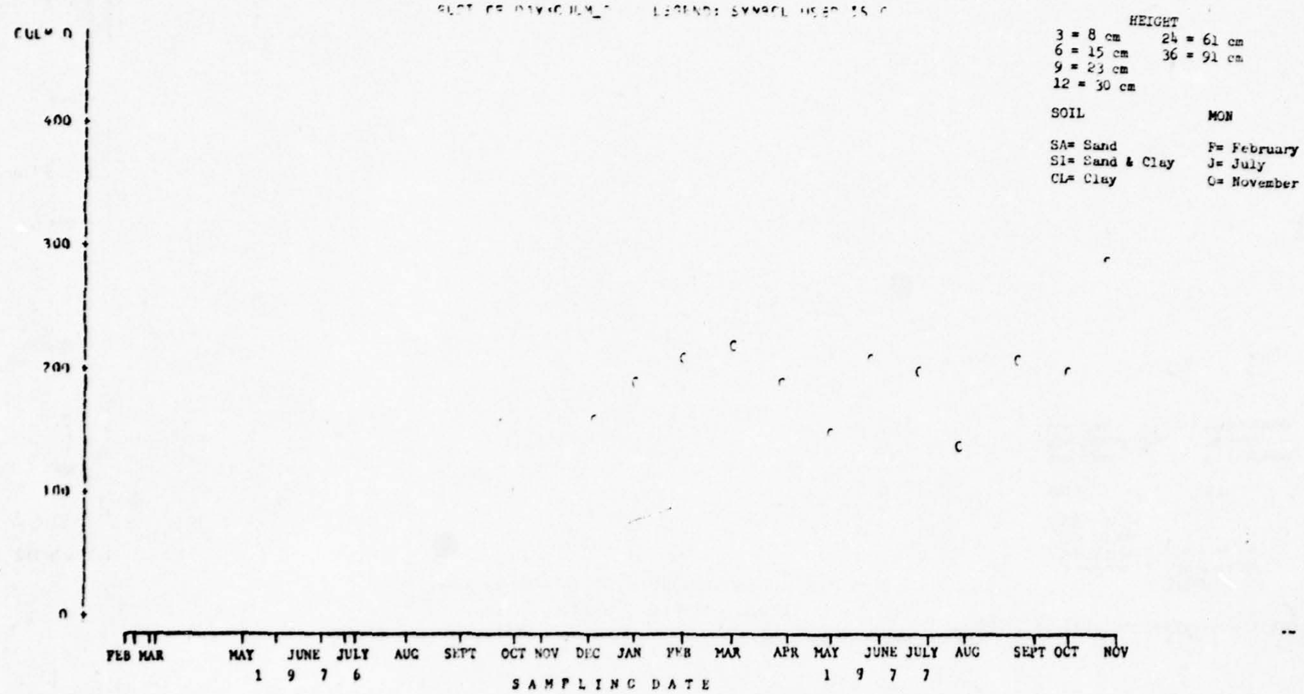
PLOT OF DAY*CULM_ LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 19

SOIL=SI MON=O

PLOT OF DAYSCULM LEGEND: SYMBOL USED IS C

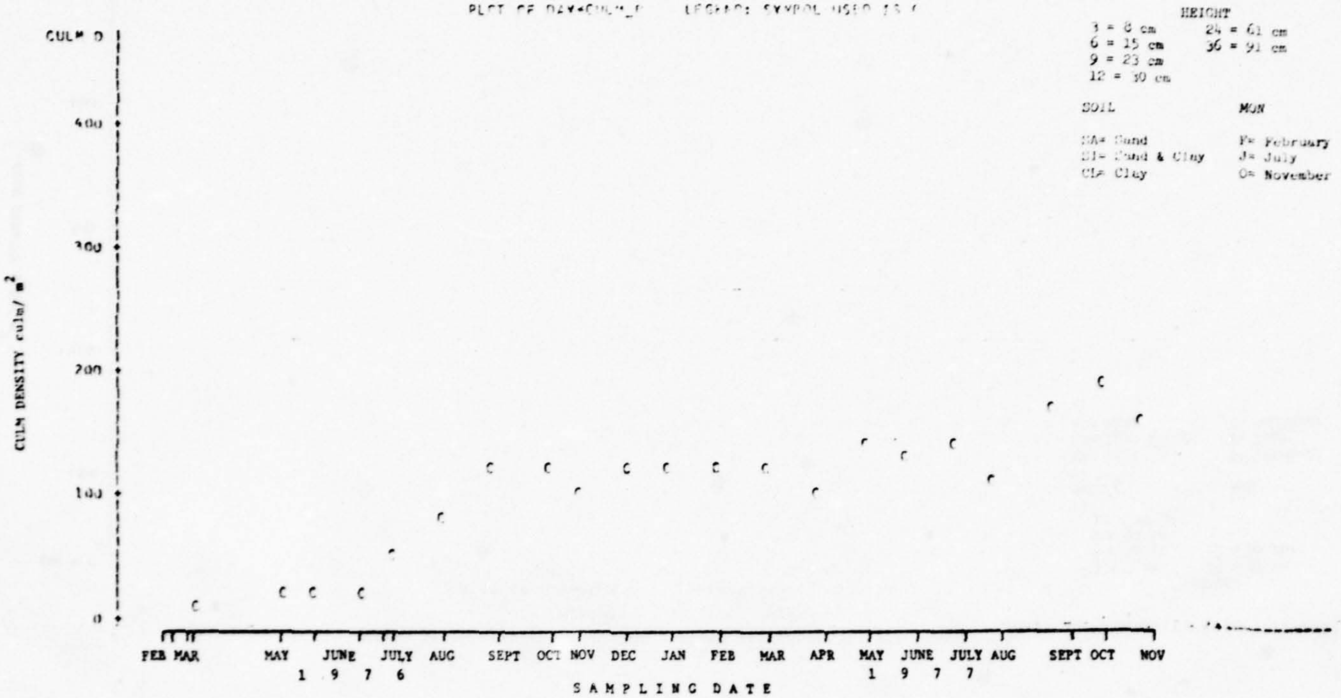


MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 20

16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=0 SOIL=CL MON=F

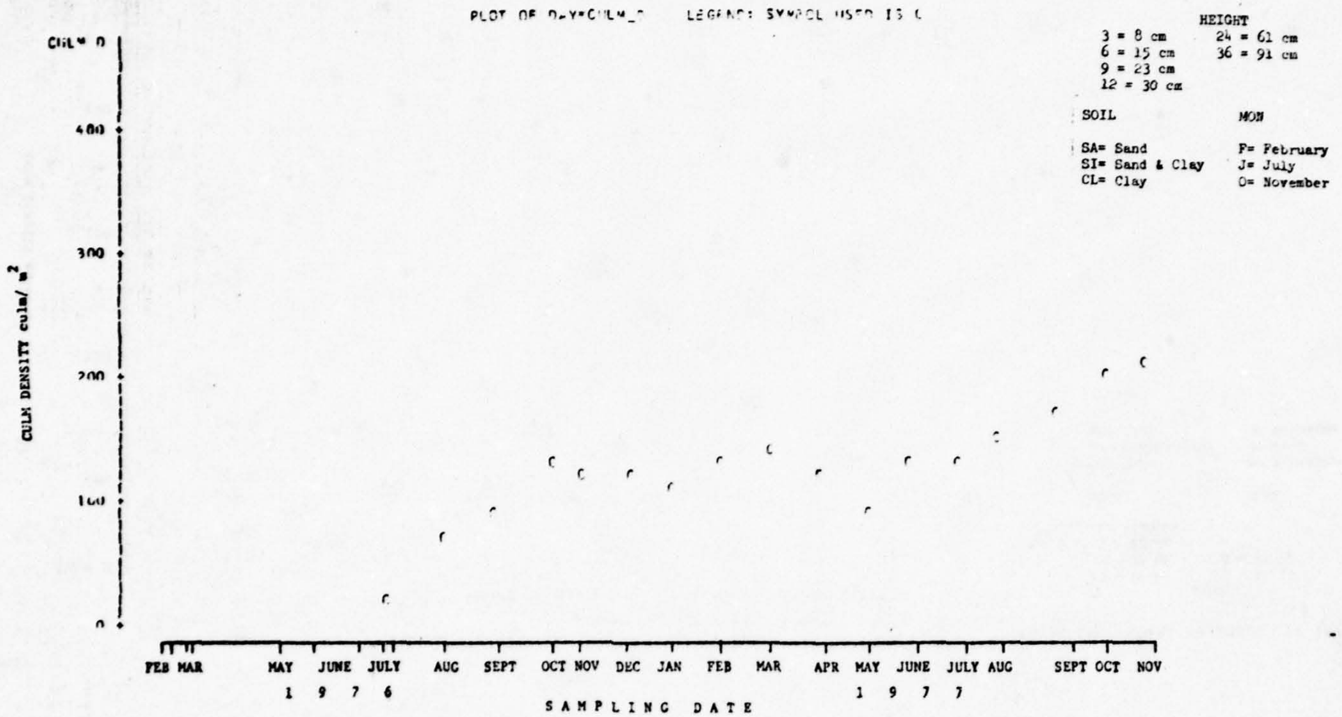
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C

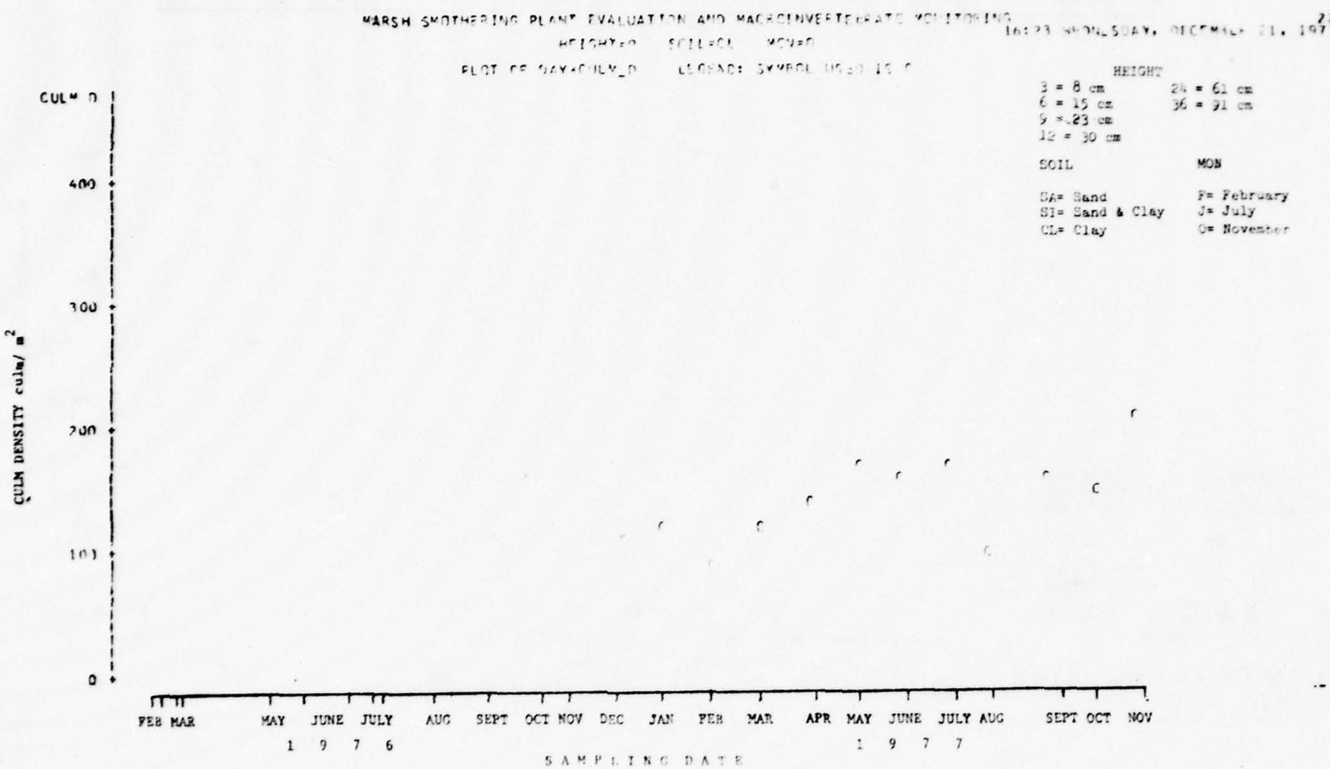


MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 21

HEIGHT=6 SOIL=CL MON=J

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C

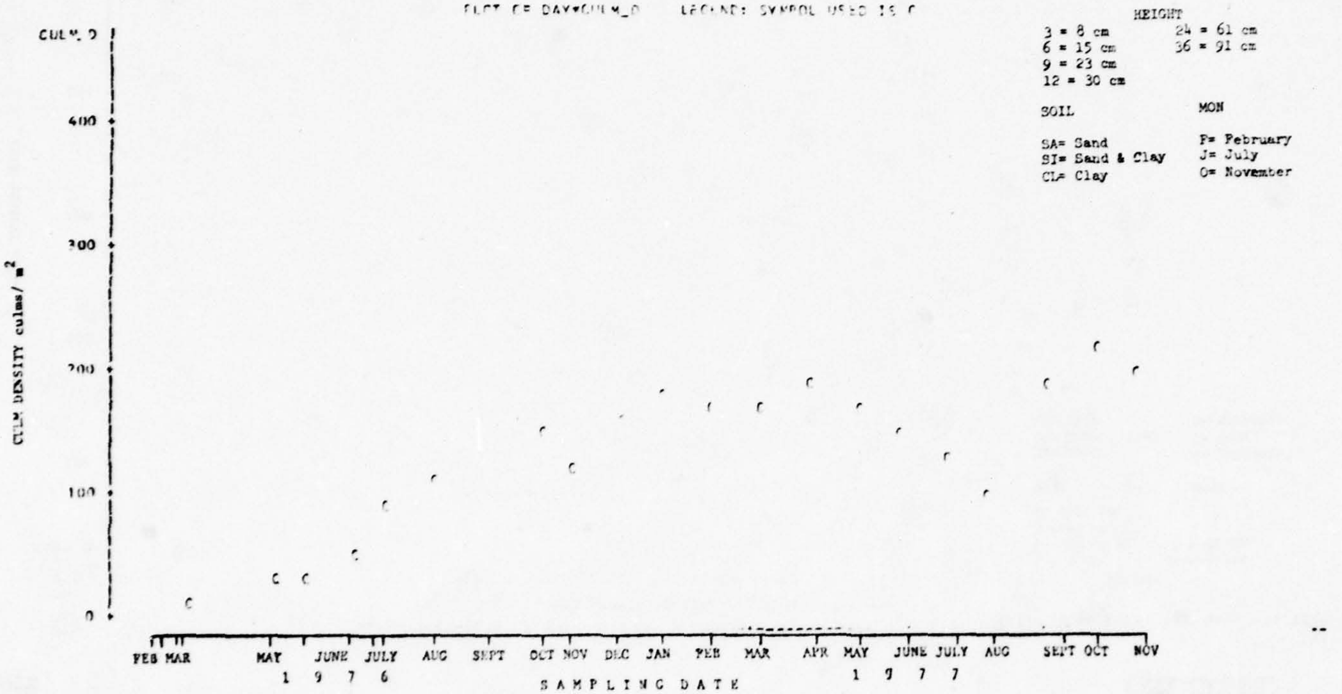



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING
16:23 WEDNESDAY, DECEMBER 21, 1977 22
HEIGHT=0 SOIL=CL MON=0
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C
HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay
MON
F= February
J= July
O= November
CULM D
400
300
200
100
0
CULM DENSITY culm/ m2
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 23
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=6 SOIL=SA MON=F

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 24
14:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=[illegible] SOIL=SA MON=J

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C

HEIGHT

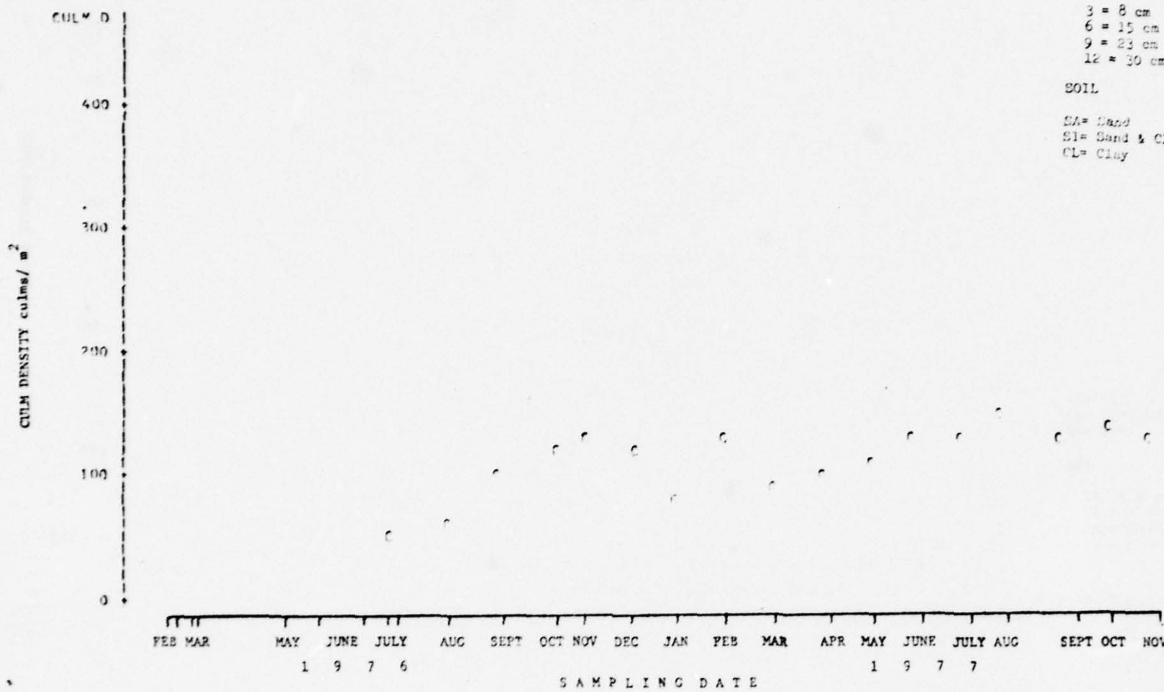
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

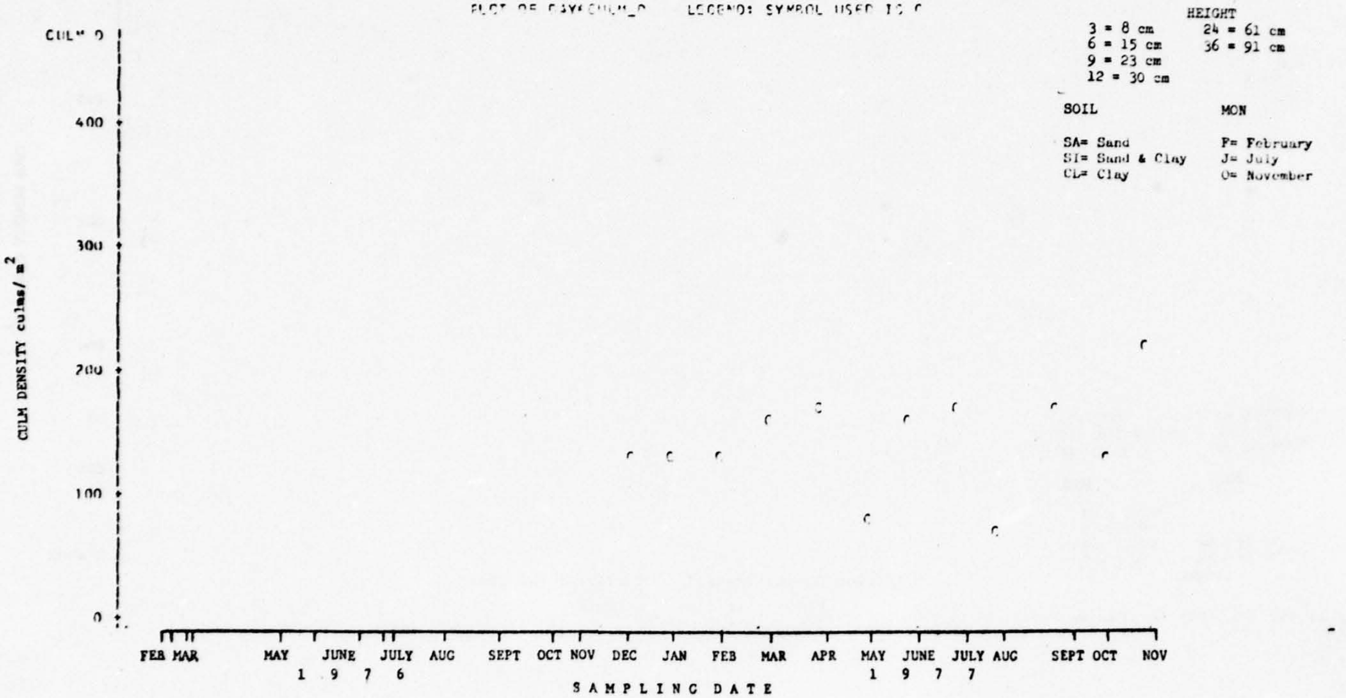
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 25

HEIGHT=0 SOIL=SA MON=O

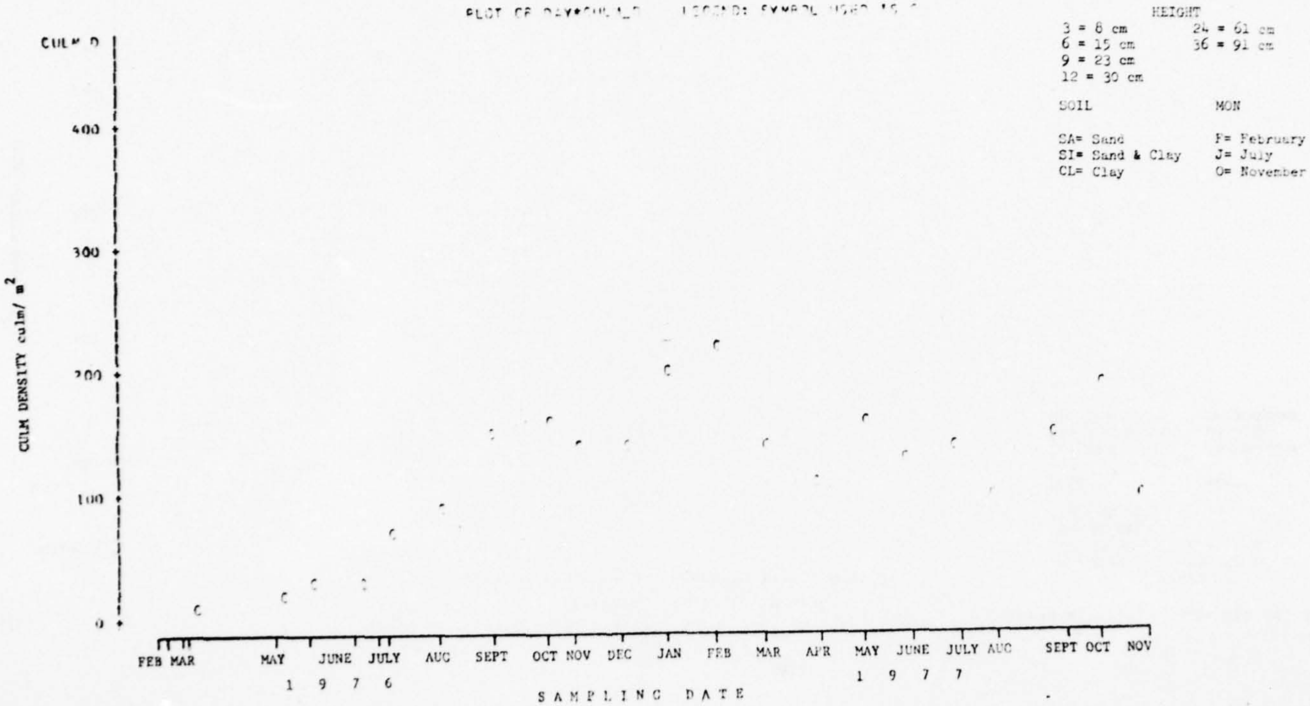
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS O



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 26

HEIGHT=9 SOIL=SI MON=F

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 27

HEIGHT=9 SOIL=SI MON=J

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C

HEIGHT

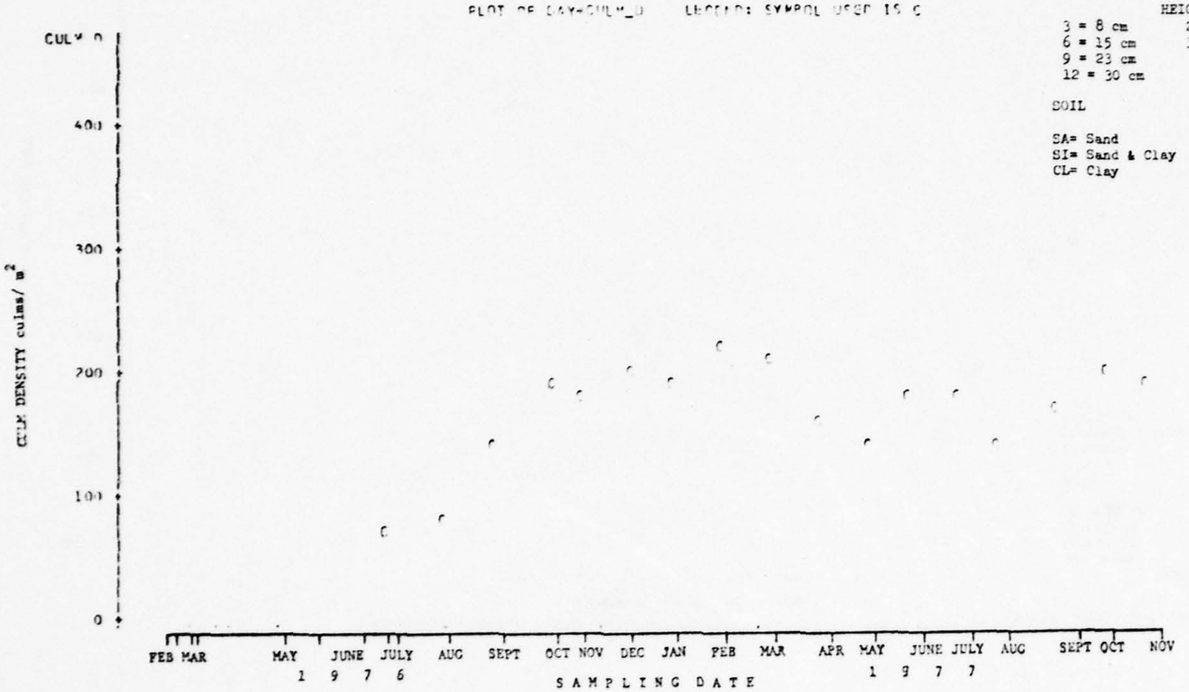
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

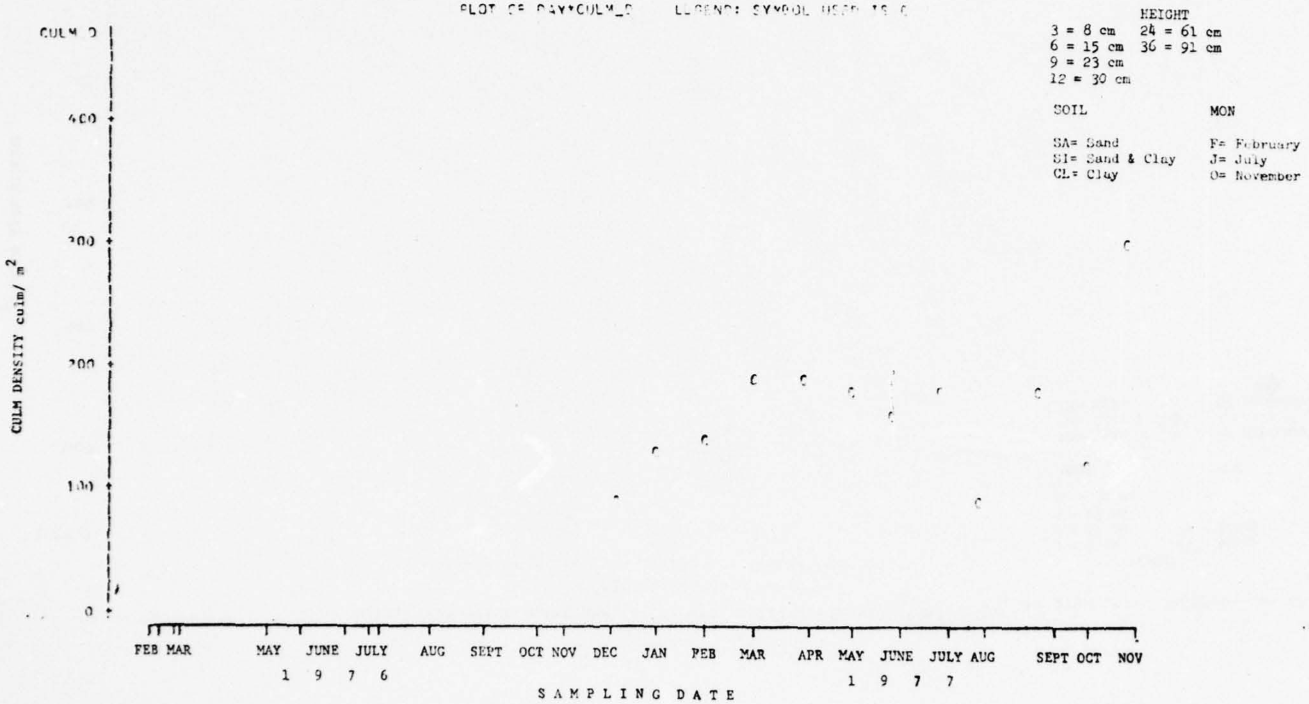
F= February
J= July
O= November



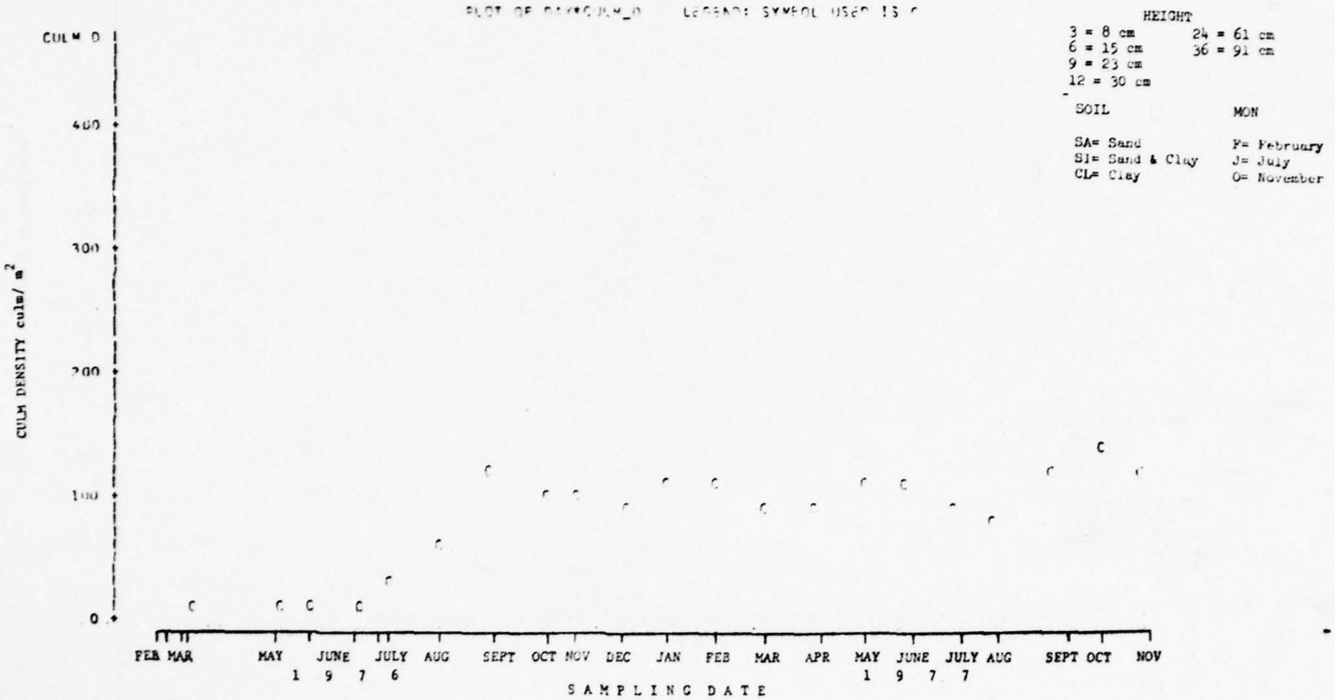
MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 28
16:22 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=9 SOIL=SI MON=O

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 29
16:33 WEDNESDAY, DECEMBER 21, 1977
HEIGHT=12 SOIL=CL MON=F
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 30

HEIGHT=12 SOIL=CL MON=J

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C

HEIGHT

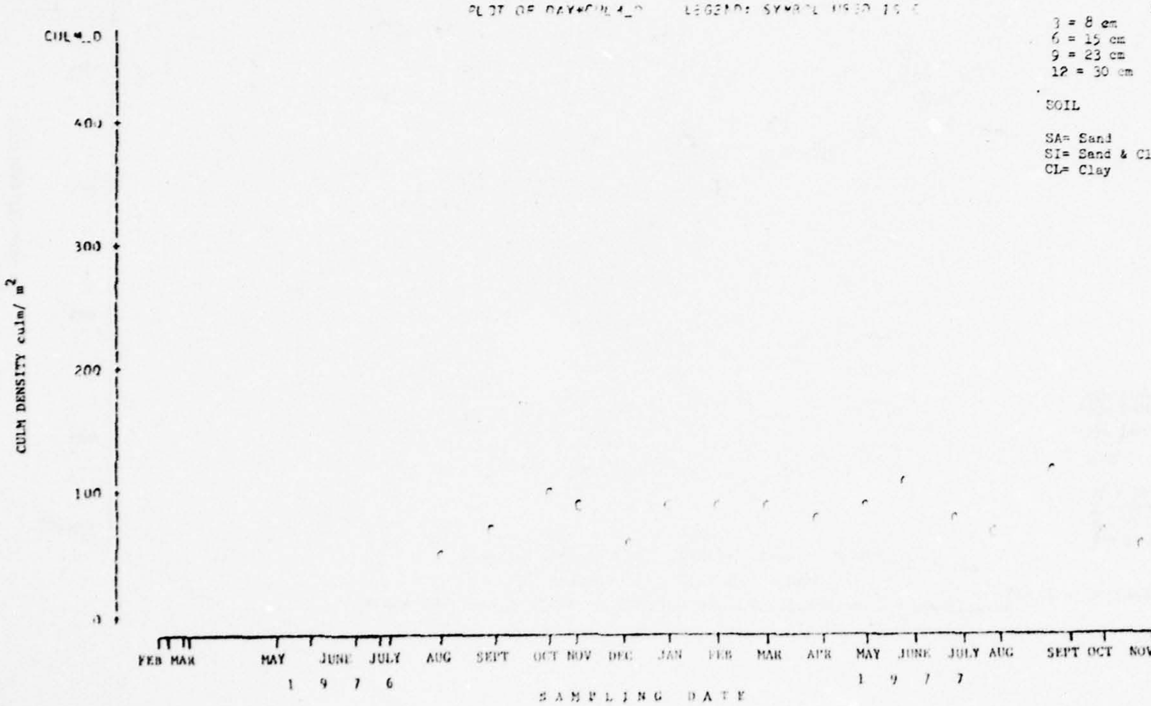
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

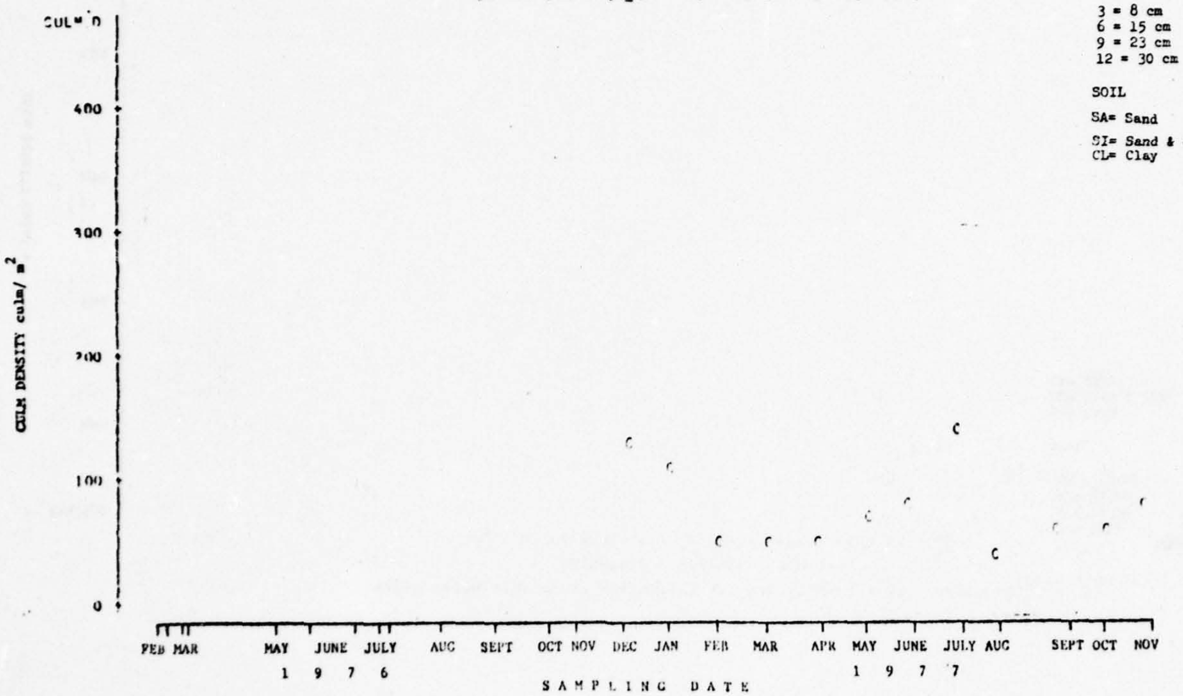
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=12 SOIL=CL MON=O

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



HEIGHT

3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 30 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

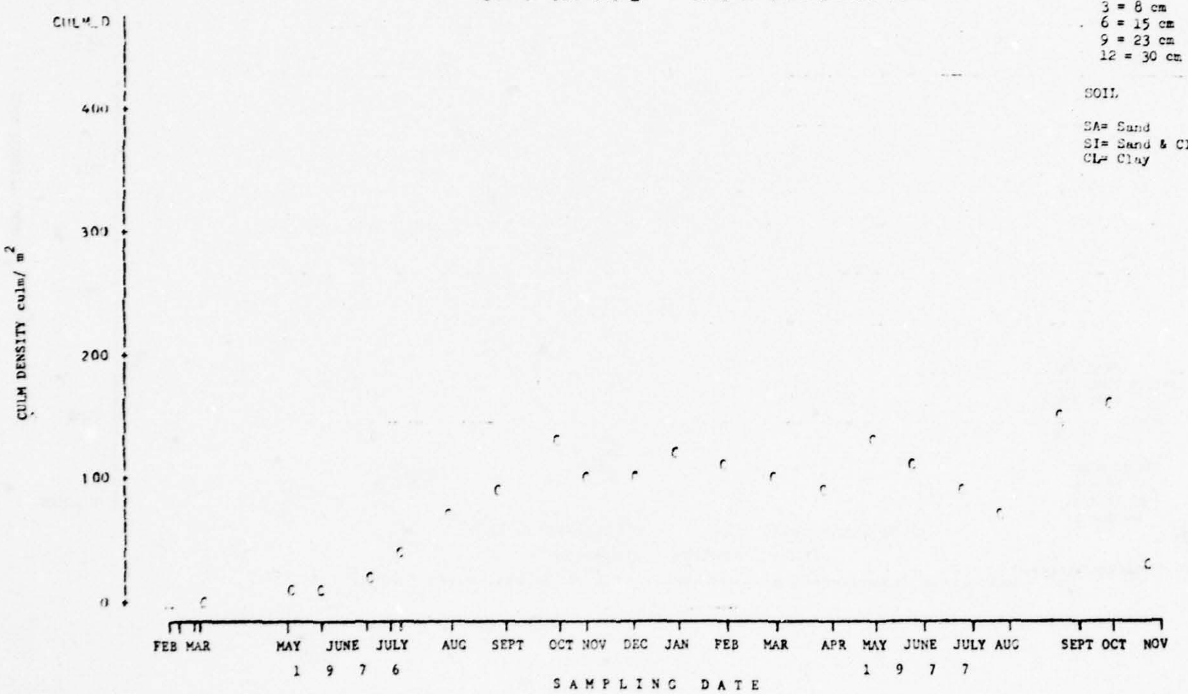
MON

F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 32

HEIGHT=12 SOIL=SA MON=F

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

HEIGHT=12 SOIL=SA MON=J

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C

HEIGHT

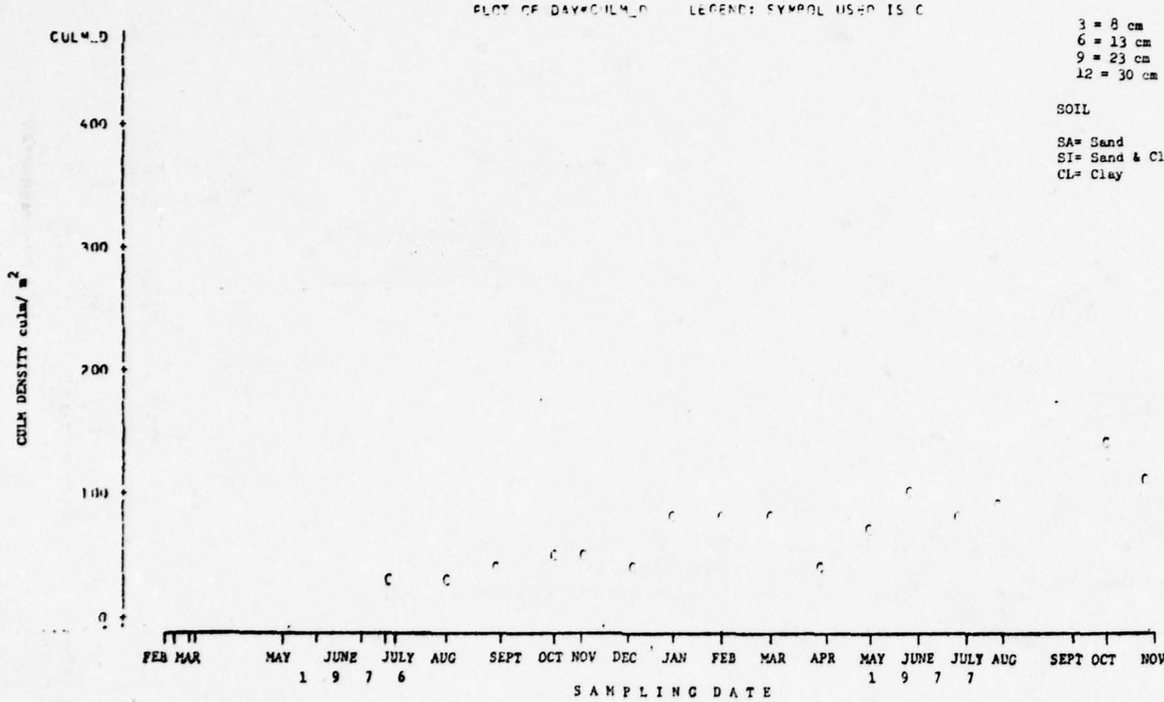
3 = 8 cm
6 = 13 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

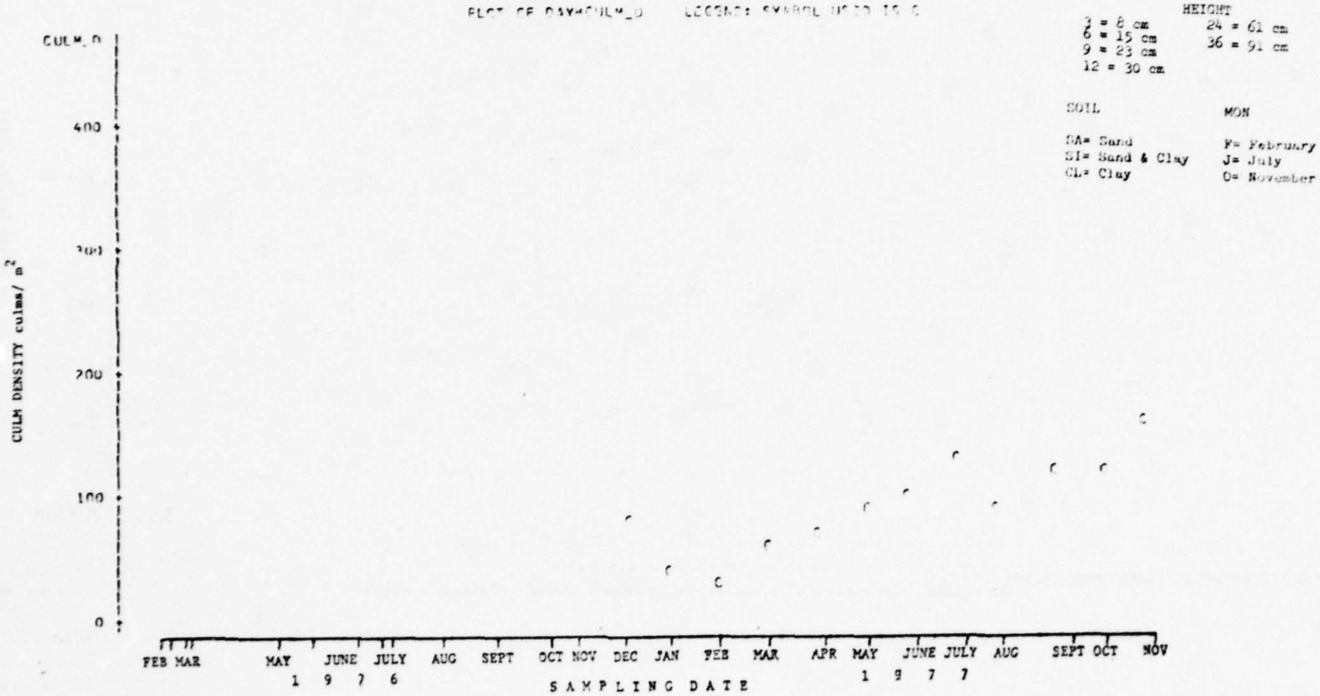
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 34

HEIGHT=12 SOIL=SA MON=O

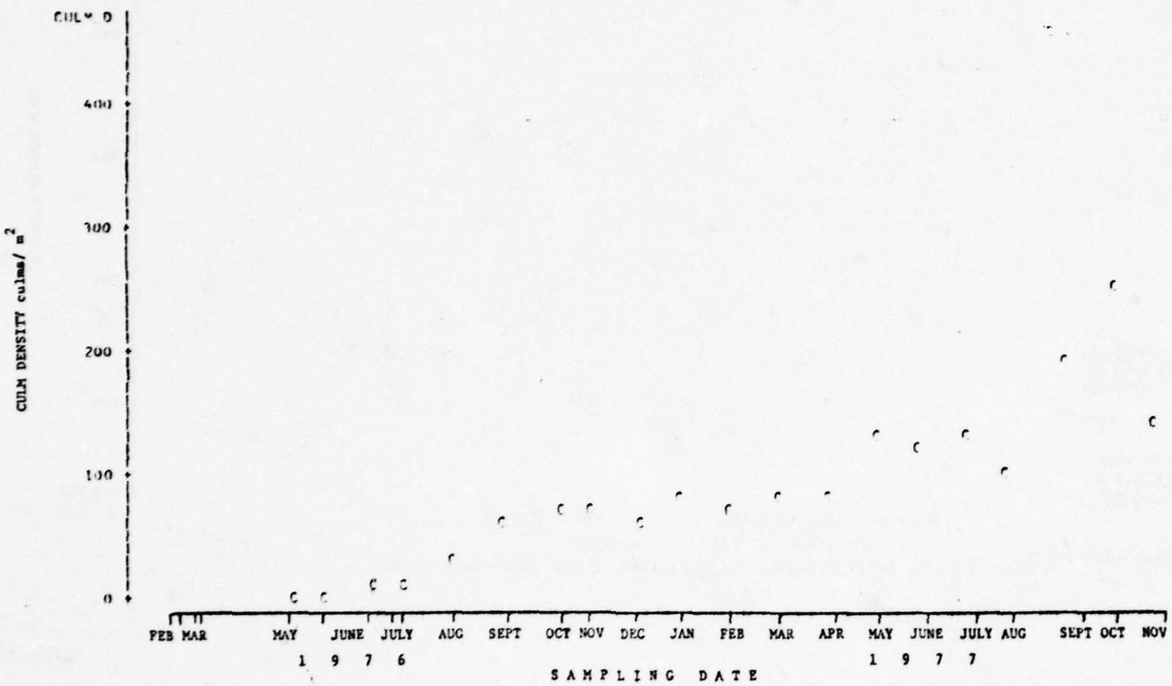
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 35

HEIGHT=12 SOIL=SI MCN=F

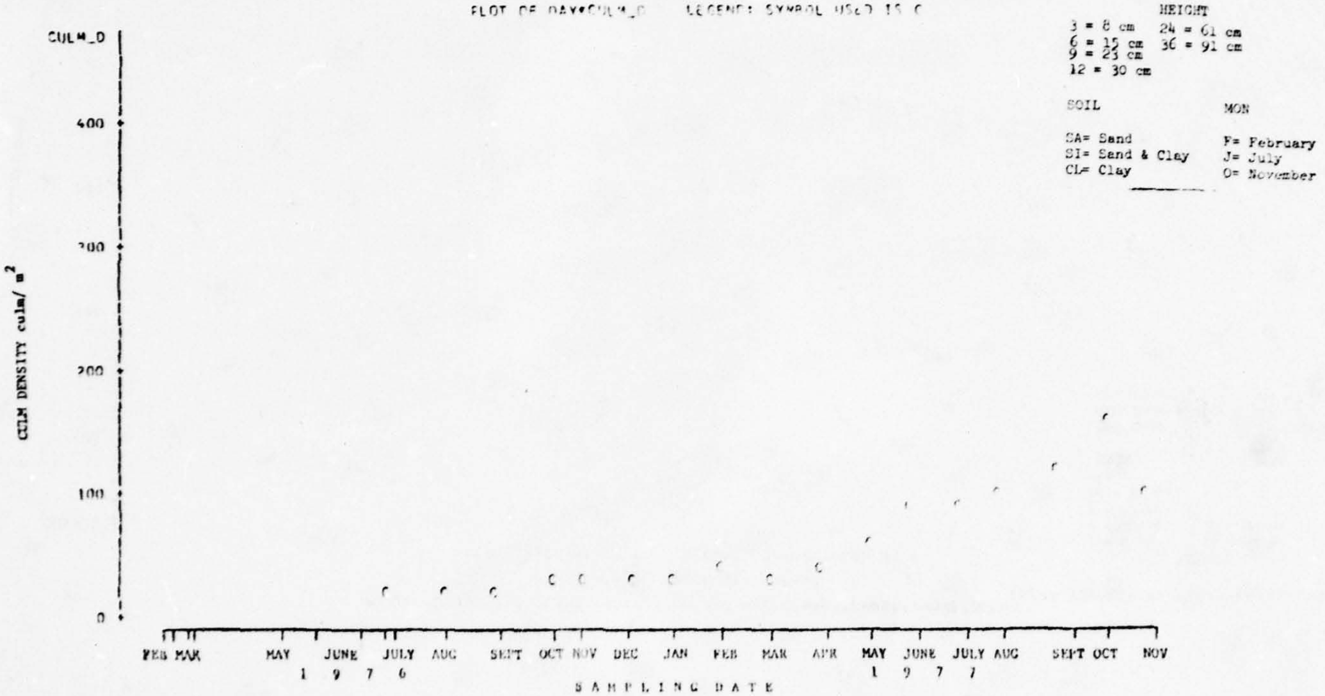
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 36

HEIGHT=12 SOIL=SI MON=J

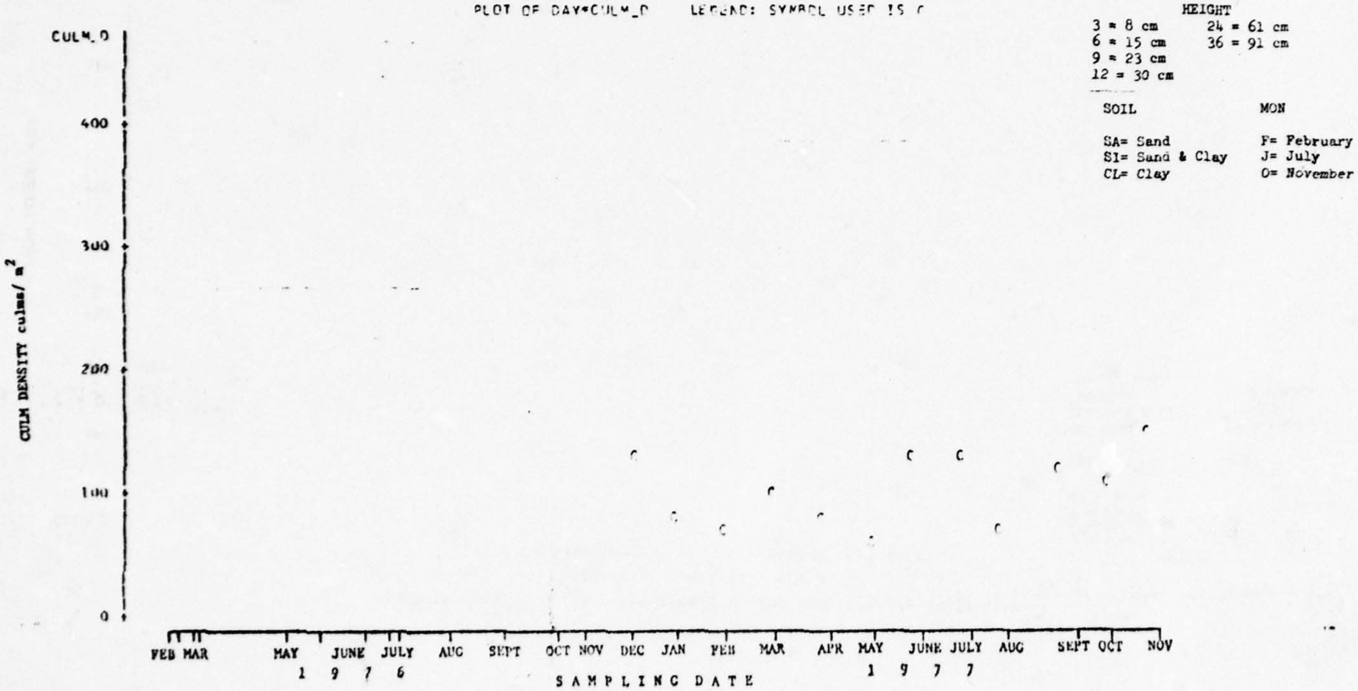
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 37

HEIGHT=12 SOIL=SI MON=O

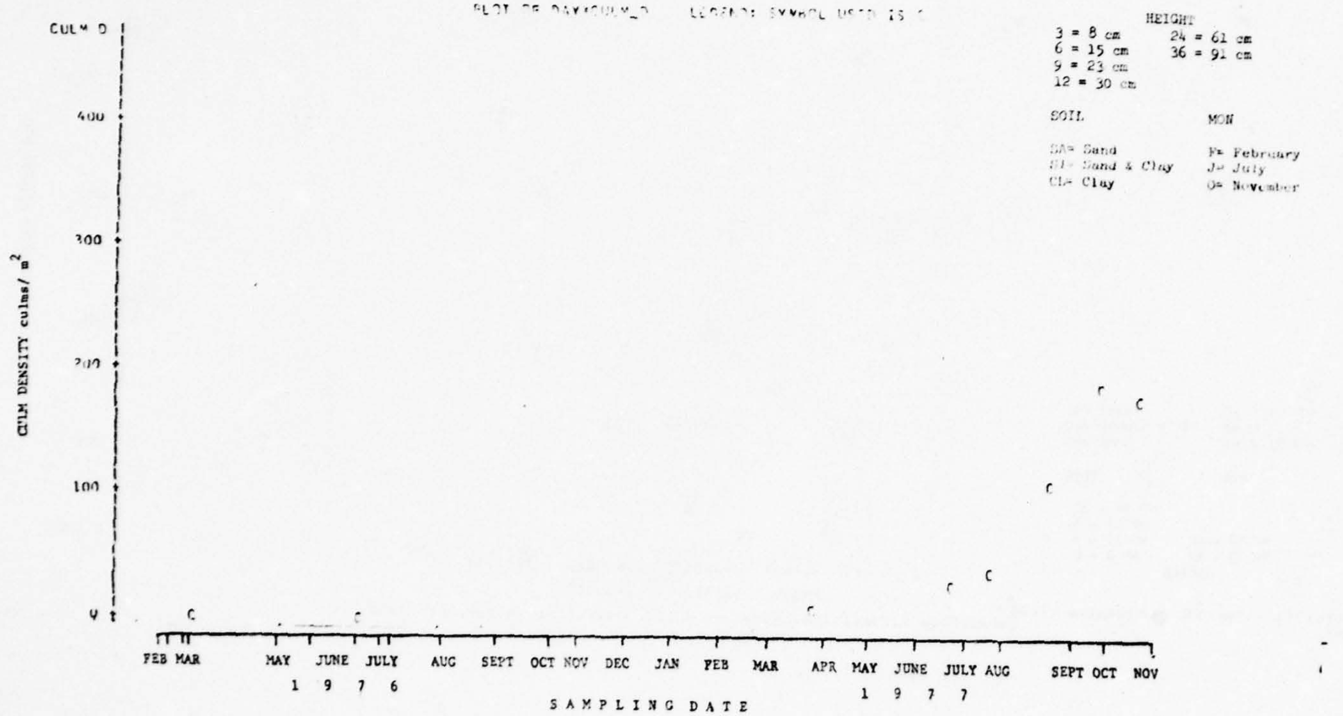
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 38

HEIGHT=24 SOIL=CL MON=F

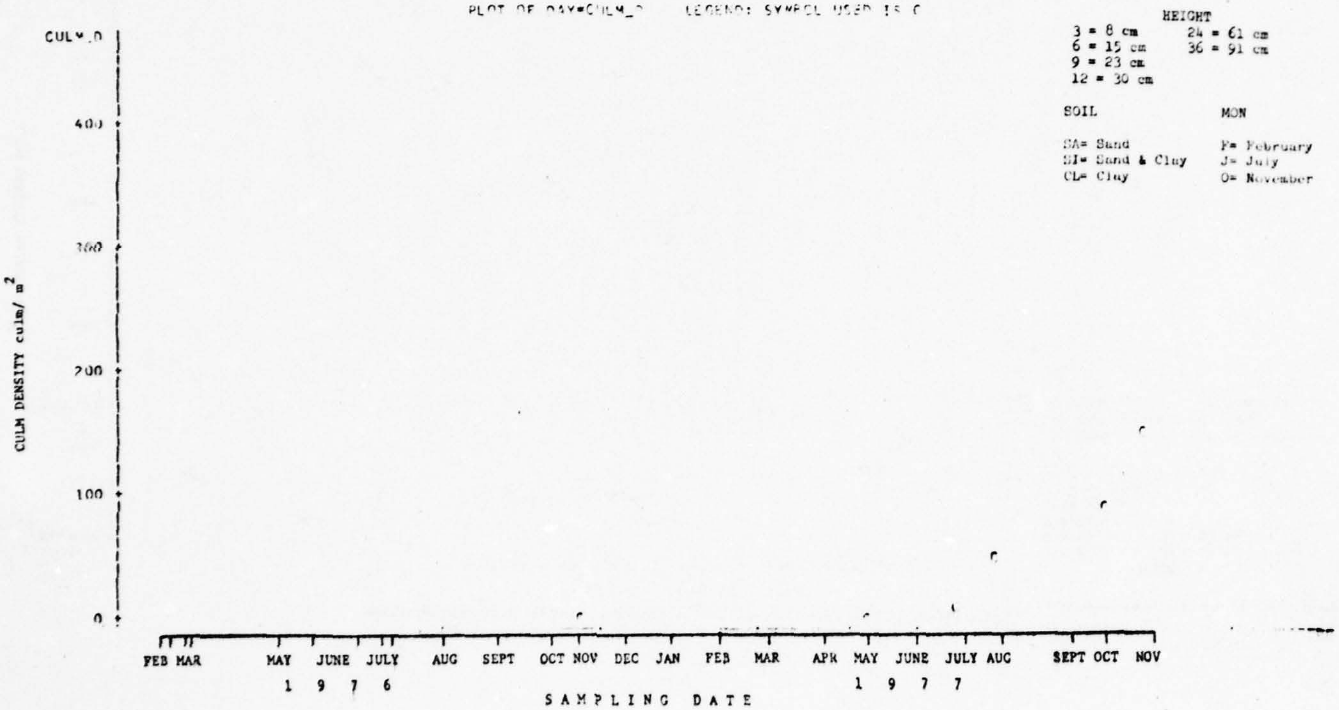
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 39

HEIGHT=24 SOIL=CL MON=J

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

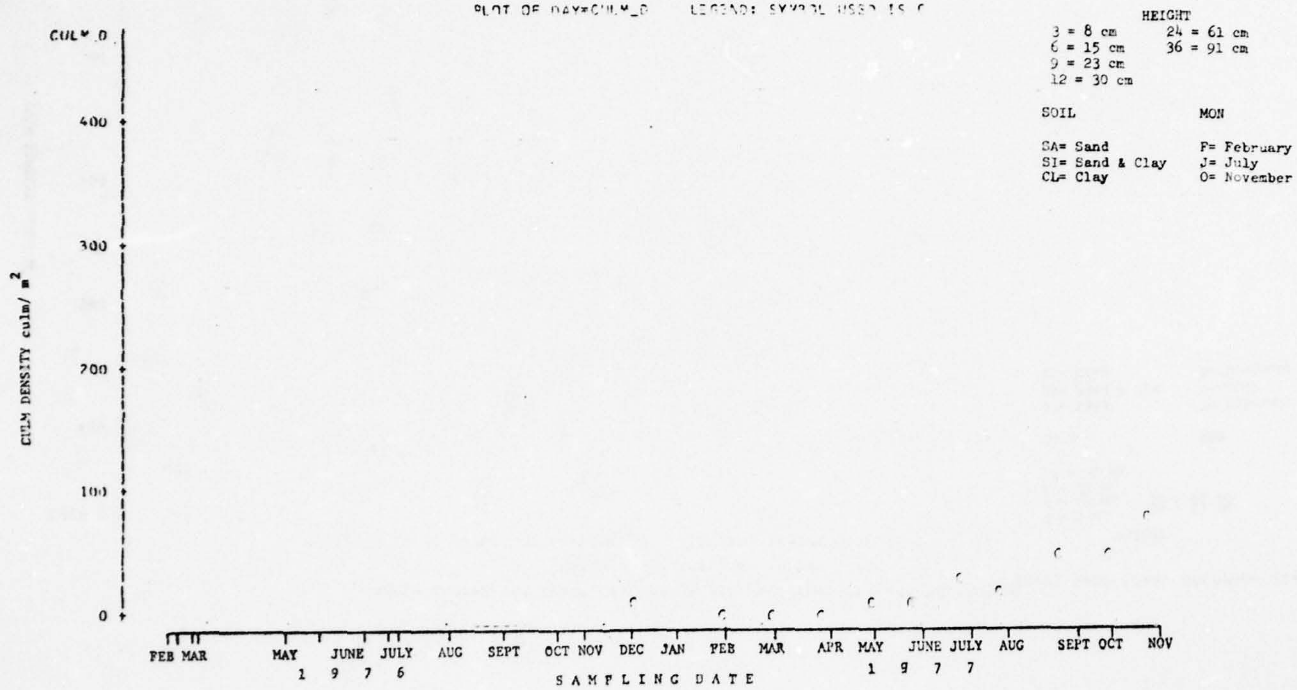
MON

F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 40

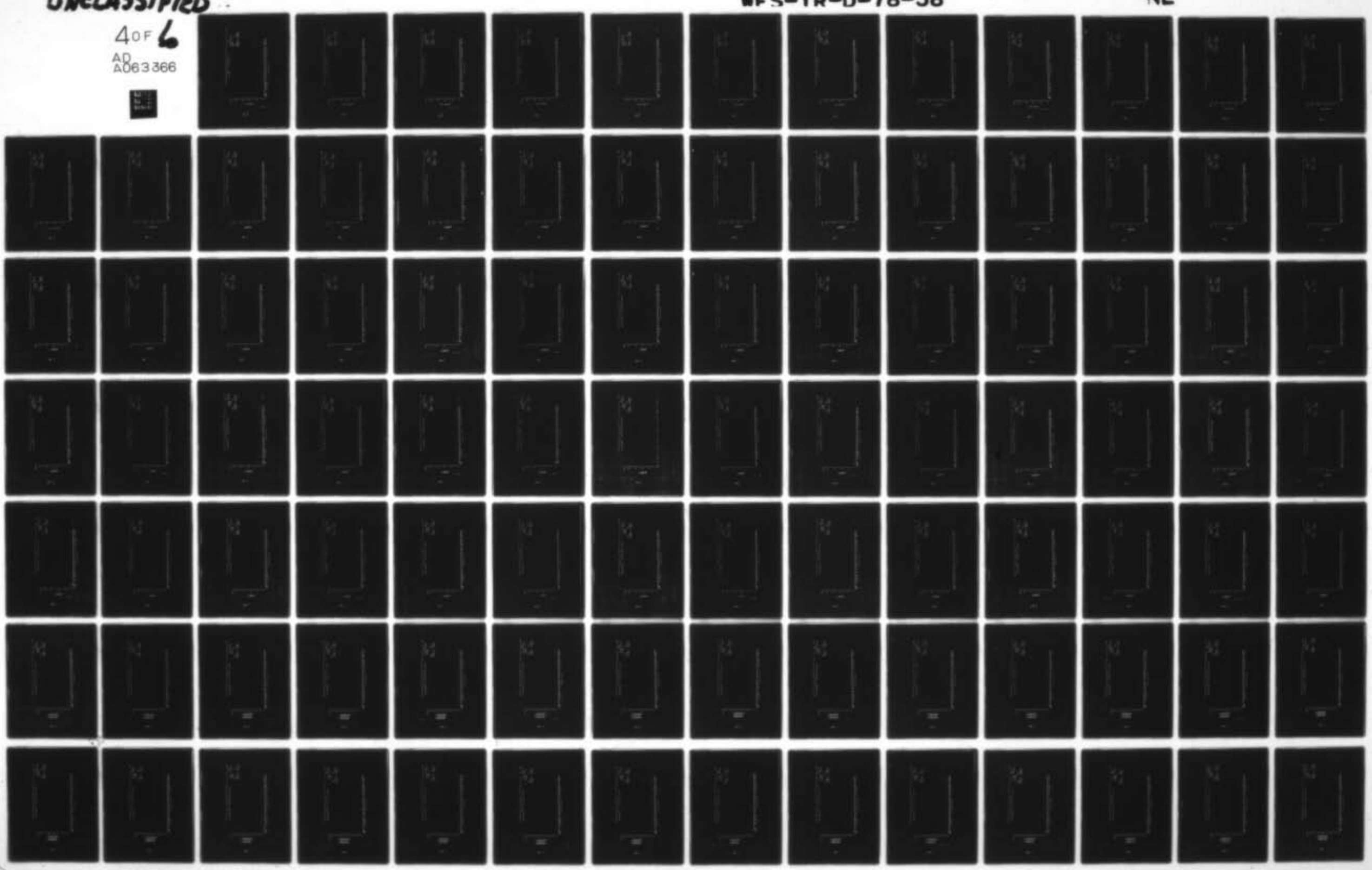
HEIGHT=24 SOIL=CL MON=O

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



AD-A063 366 GEORGIA UNIV BRUNSWICK MARINE EXTENSION SERVICE F/G 13/2
THE EFFECTS OF SMOTHERING A 'SPARTINA ALTERNIFLORA' SALT MARSH --ETC(U)
JUL 78 R J REIMOLD, M A HARDISKY, P C ADAMS DACW21-75-C-0074
UNCLASSIFIED WES-TR-D-78-38 NL

4 OF 6
AD A063366



ASSIFIE

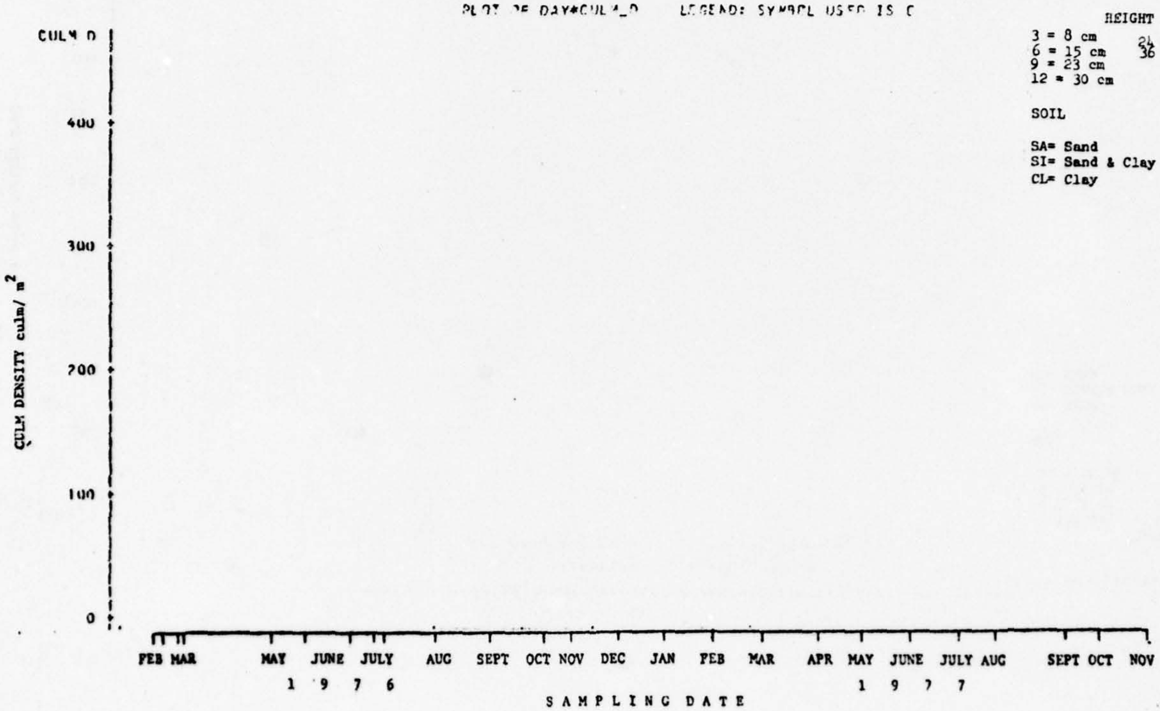
4 OF 6

AD
A063366

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 10:23 WEDNESDAY, DECEMBER 21, 1977 41

HEIGHT=24 SOIL=SA MON=F

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

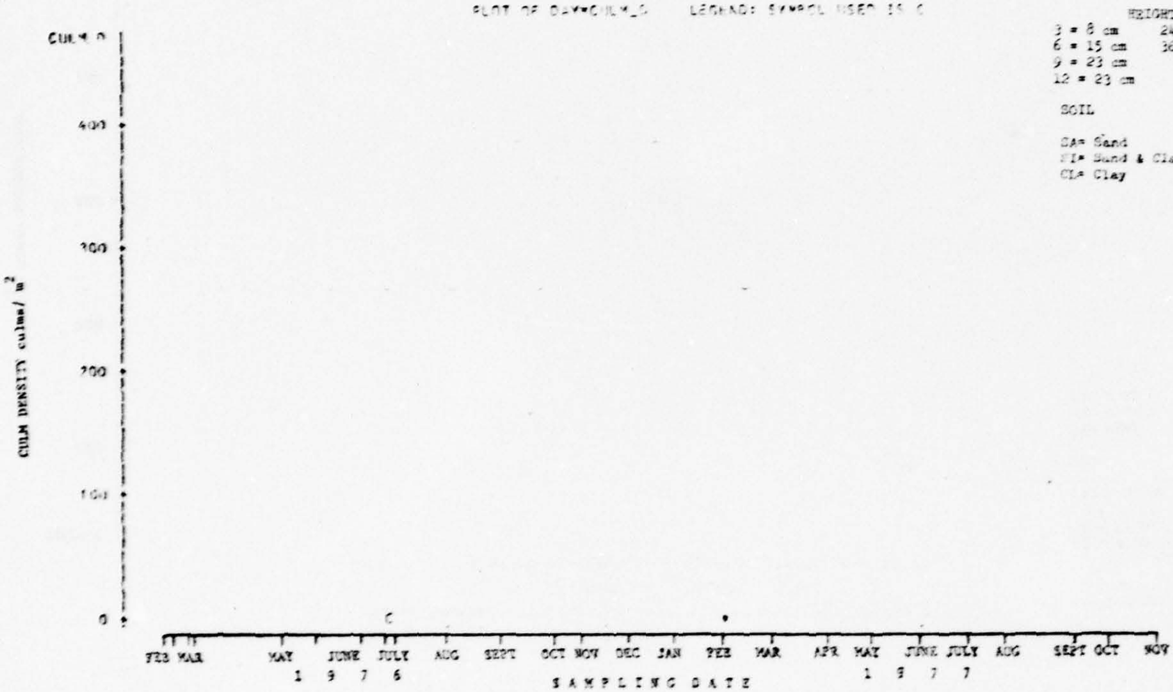
MON

F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 42
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=36 SOIL=SA MON=J

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



HEIGHT

3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 23 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

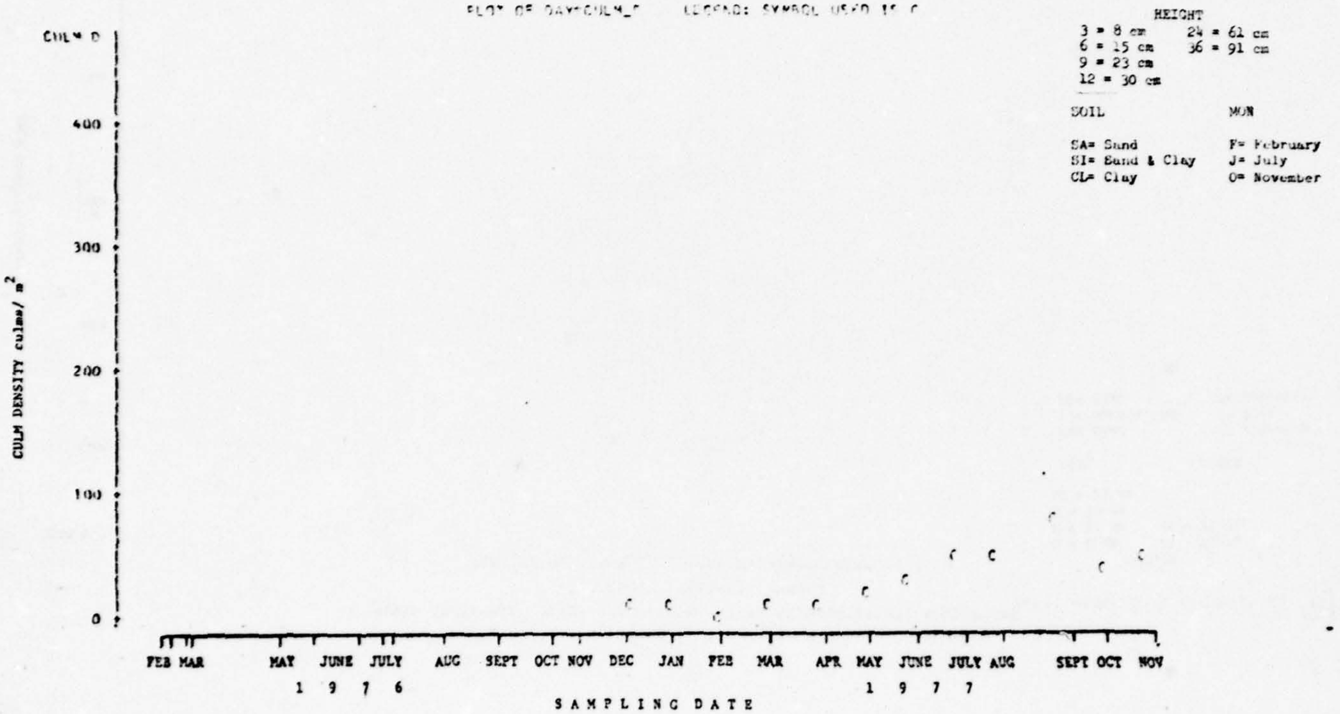
MON

F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 43

HEIGHT=24 SOIL=SA MON=0

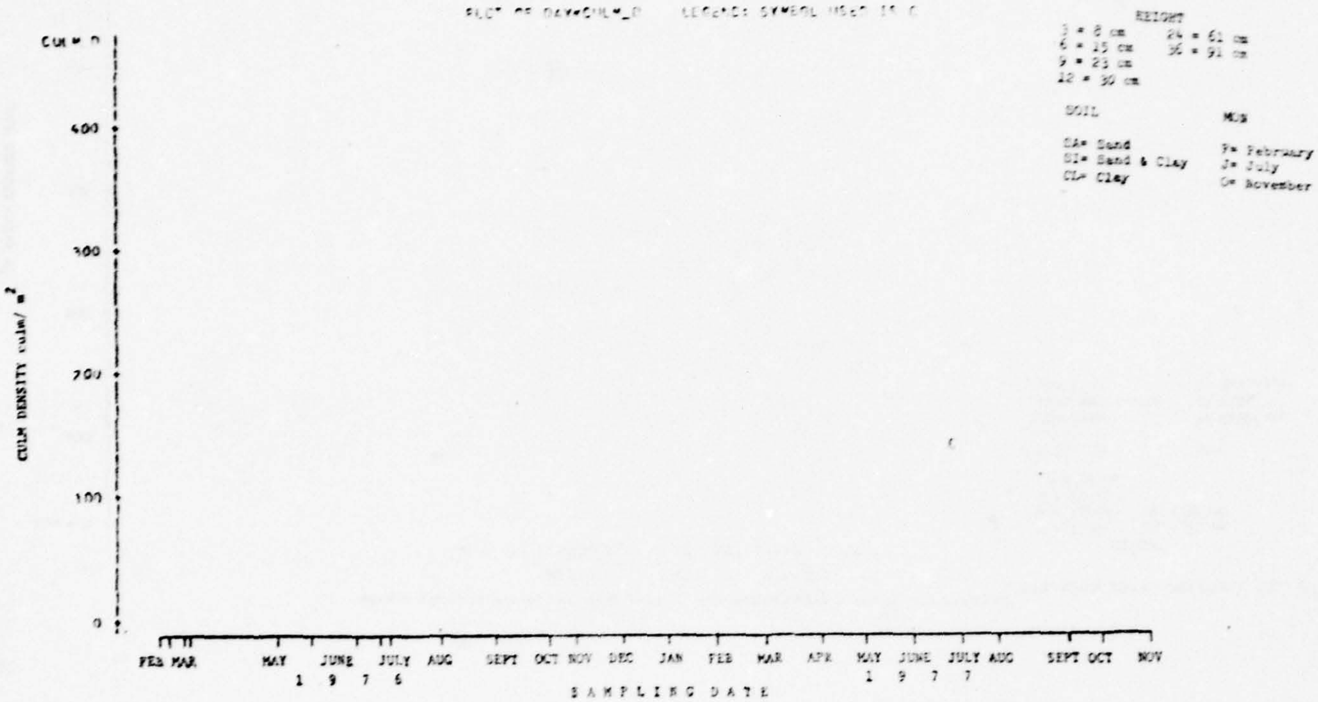
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 44

HEIGHT=24 SOIL=SI MON=F

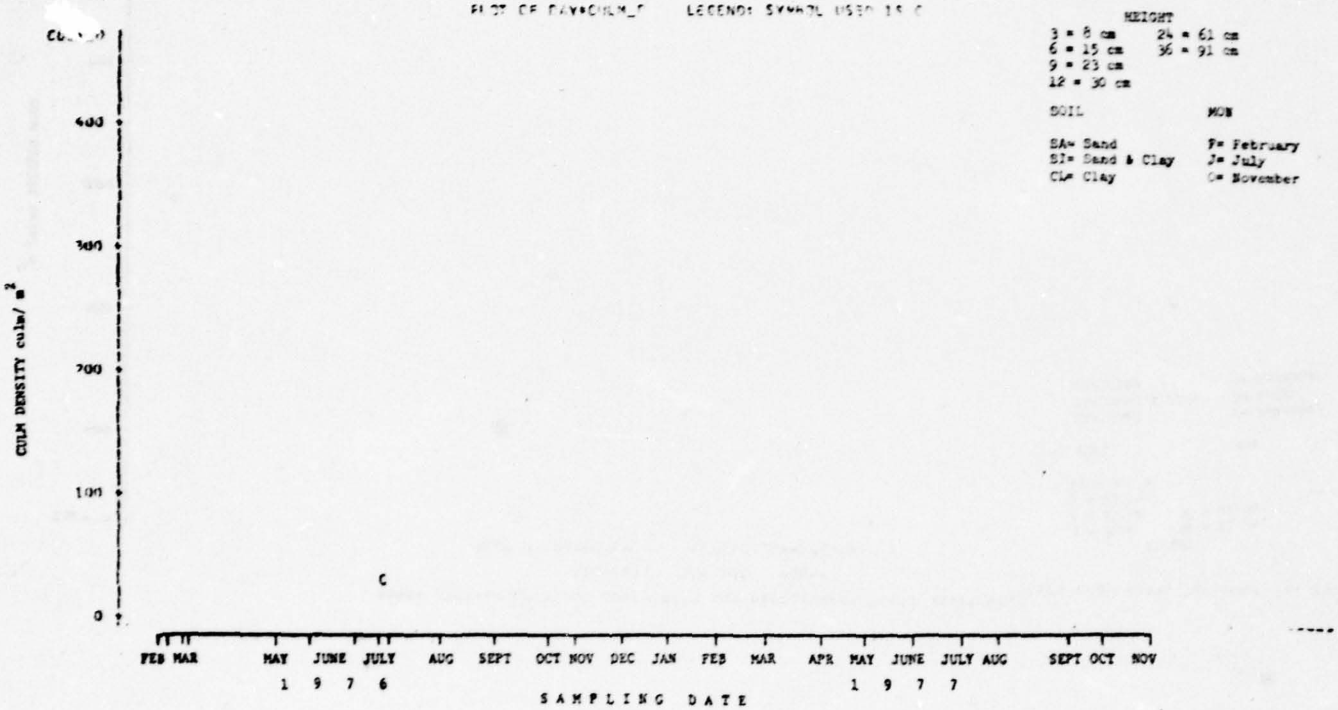
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 45

HEIGHT=24 SOIL=SI MON=J

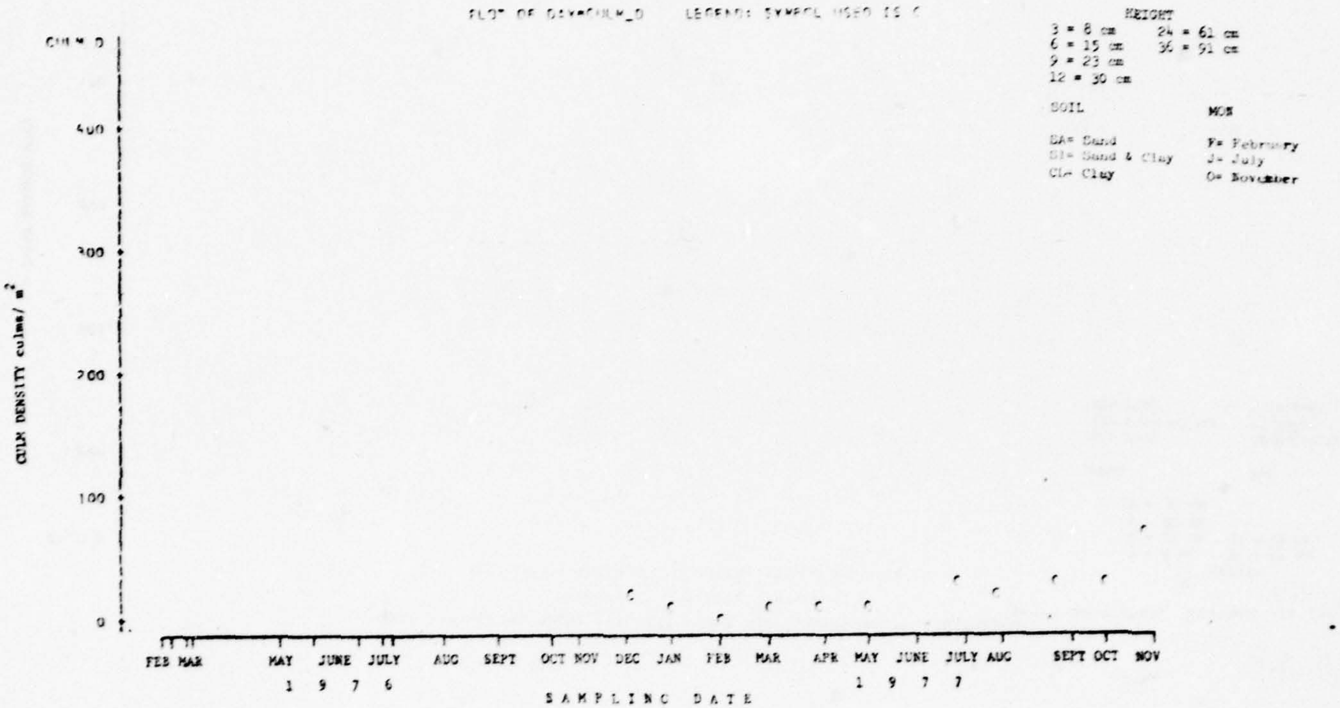
PLOT OF DAY*CULM_F LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 46

HEIGHT=24 SOIL=SI MON=O

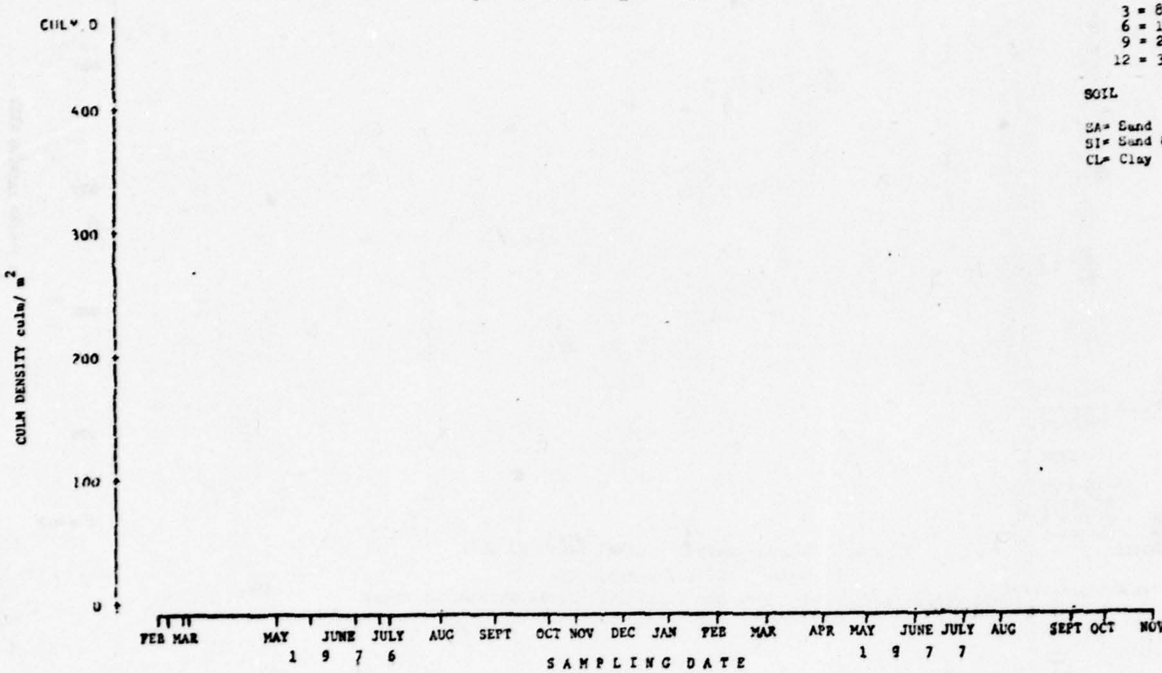
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 47

HEIGHT=36 SOIL=CL MON=F

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

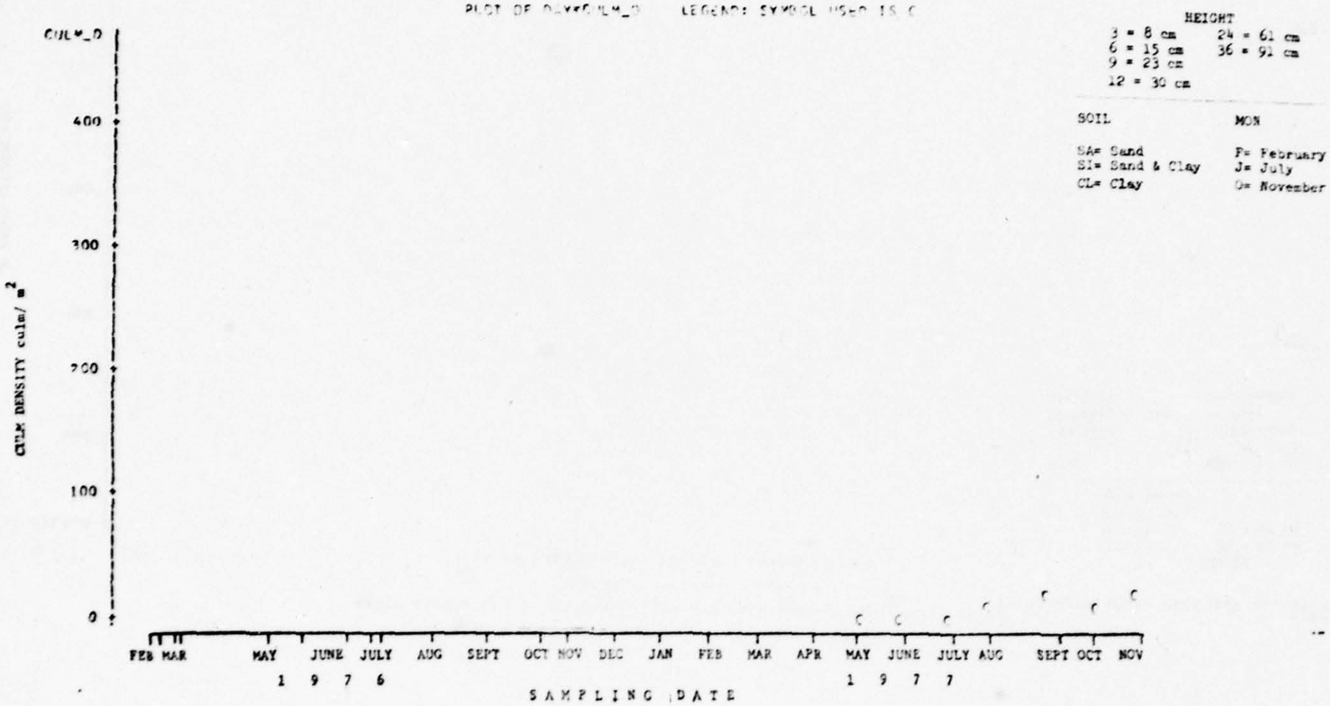
F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 48

16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=36 SOIL=CL MON=J

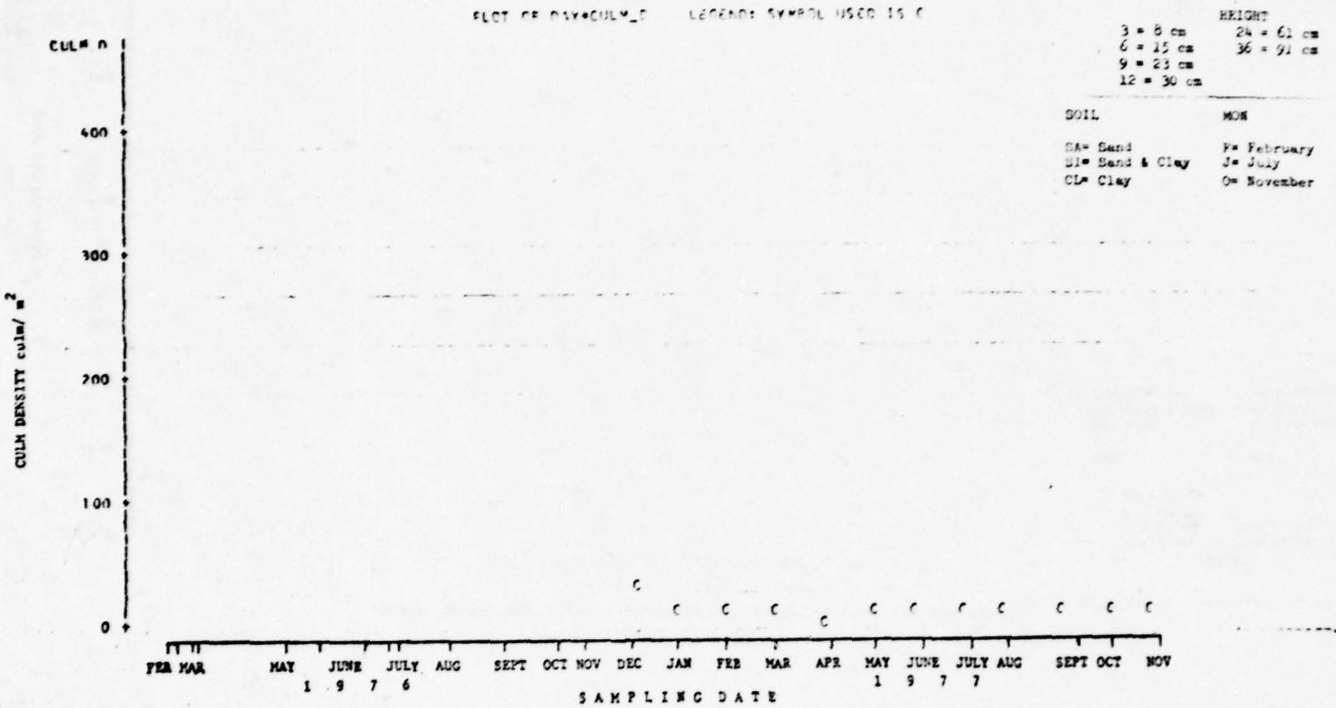
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 49

HIGHT=36 SOIL=CL MON=O

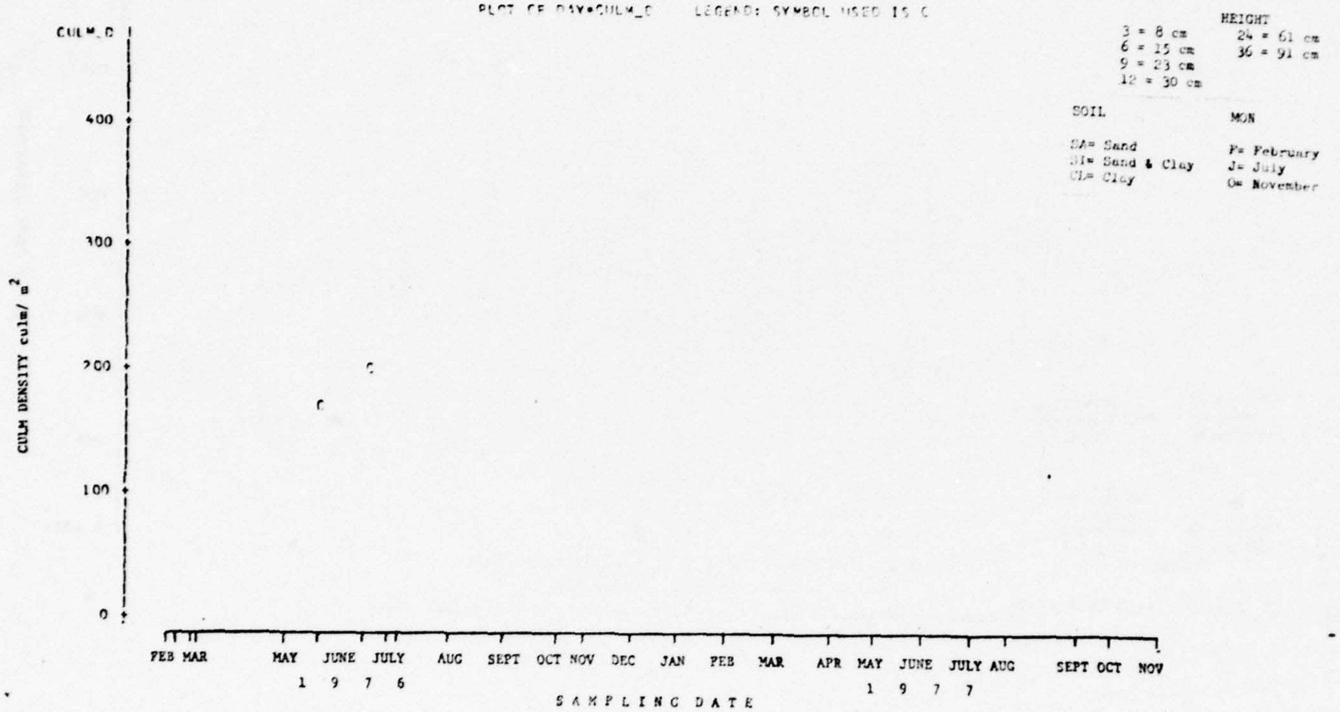
PLOT OF DSY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 59

HEIGHT=36 SOIL=SA MON=F

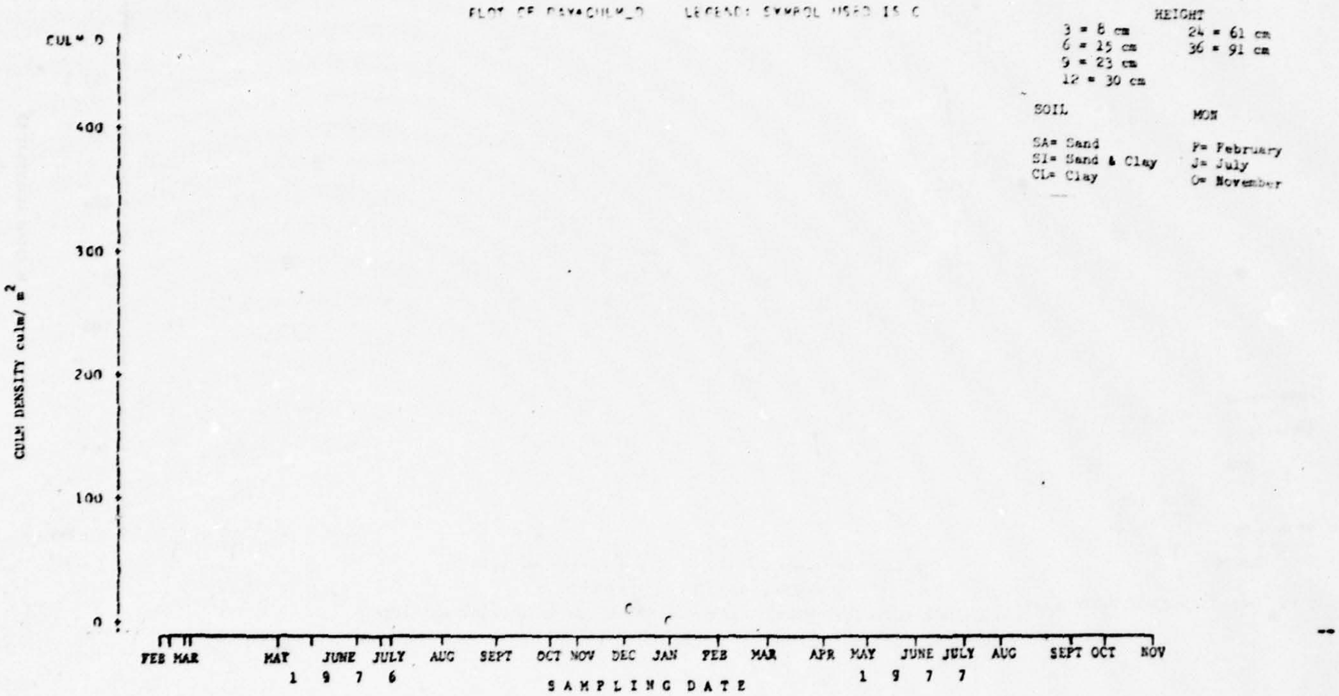
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 51

HEIGHT=36 SOIL=SA MON=O

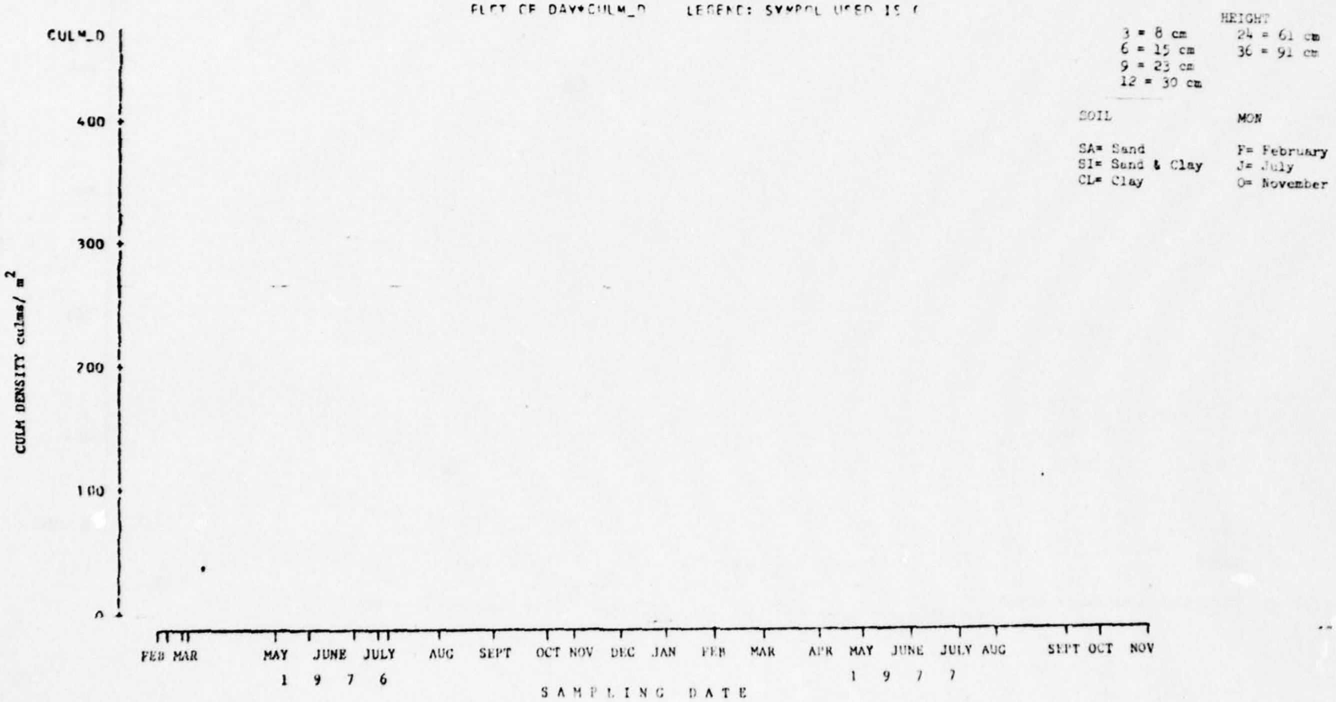
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 52

HEIGHT=36 SOIL=CI MON=F

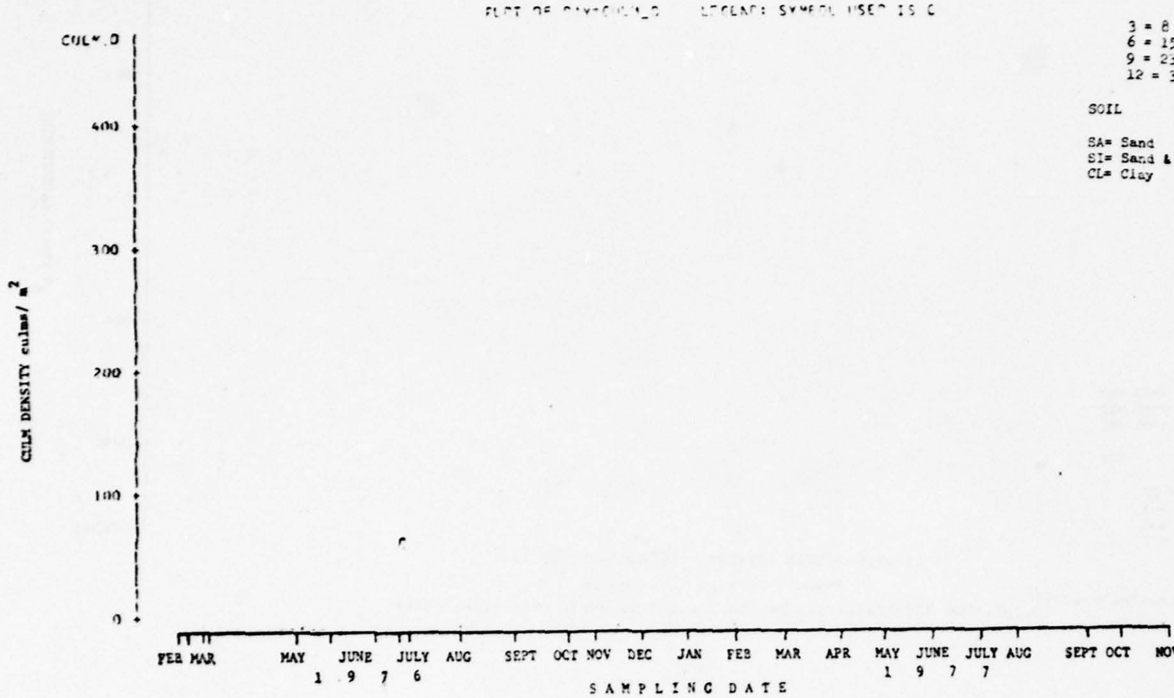
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS (



MARSH ENGINEERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 53

HEIGHT=36 SOIL=SI MON=J

PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



HEIGHT

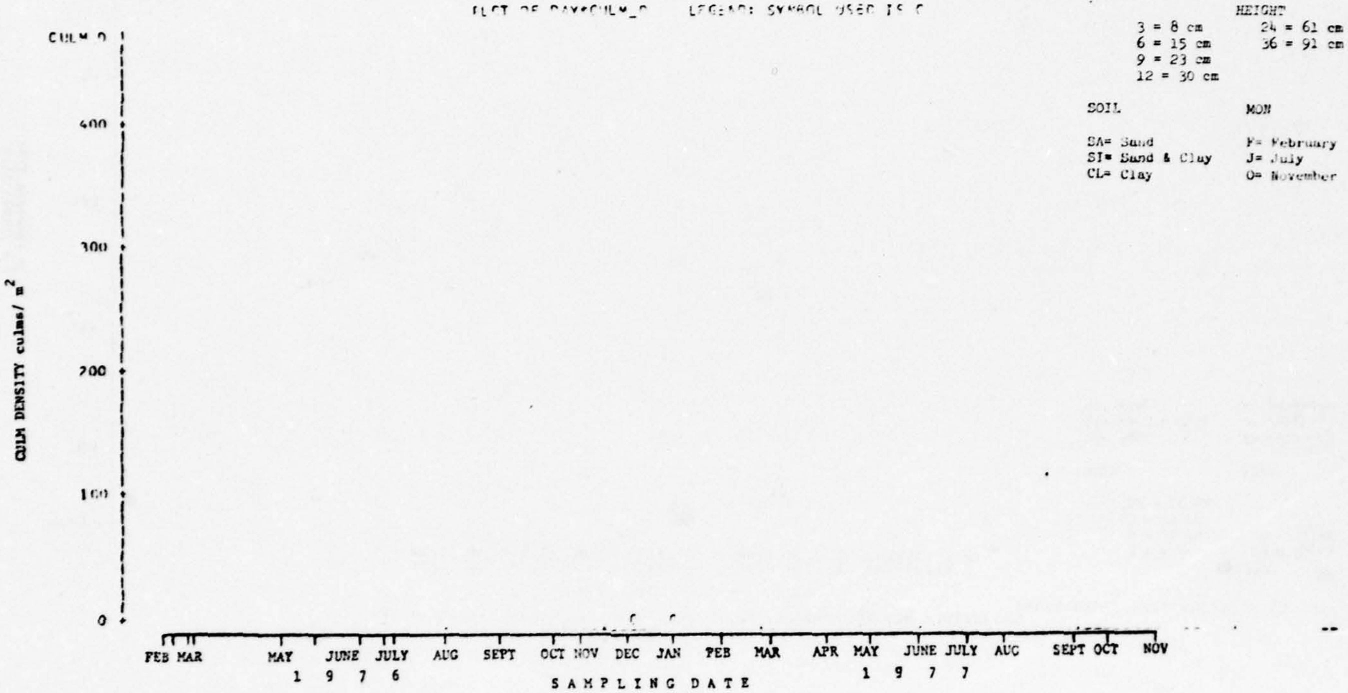
3 = 8 cm	24 = 61 cm
6 = 15 cm	36 = 91 cm
9 = 23 cm	
12 = 30 cm	

SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 54
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=36 SOIL=SI MON=O

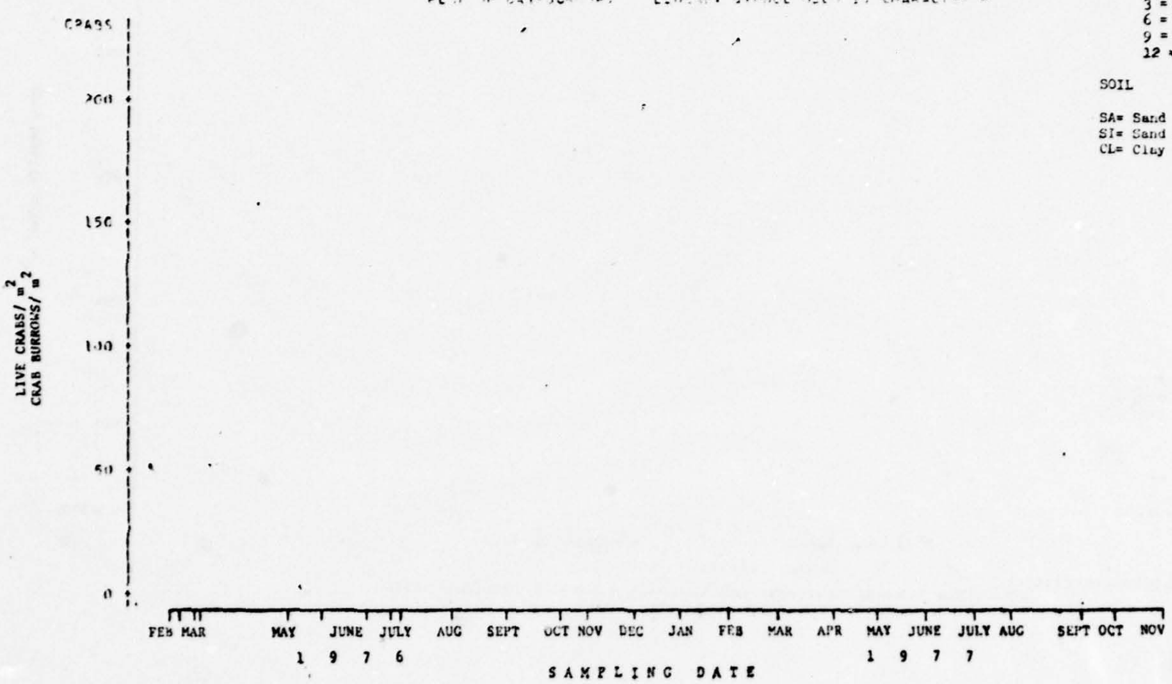
PLOT OF DAY*CULM_D LEGEND: SYMBOL USED IS C



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 55
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=. SOIL= MON=

PLOT OF DAY*GRASS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

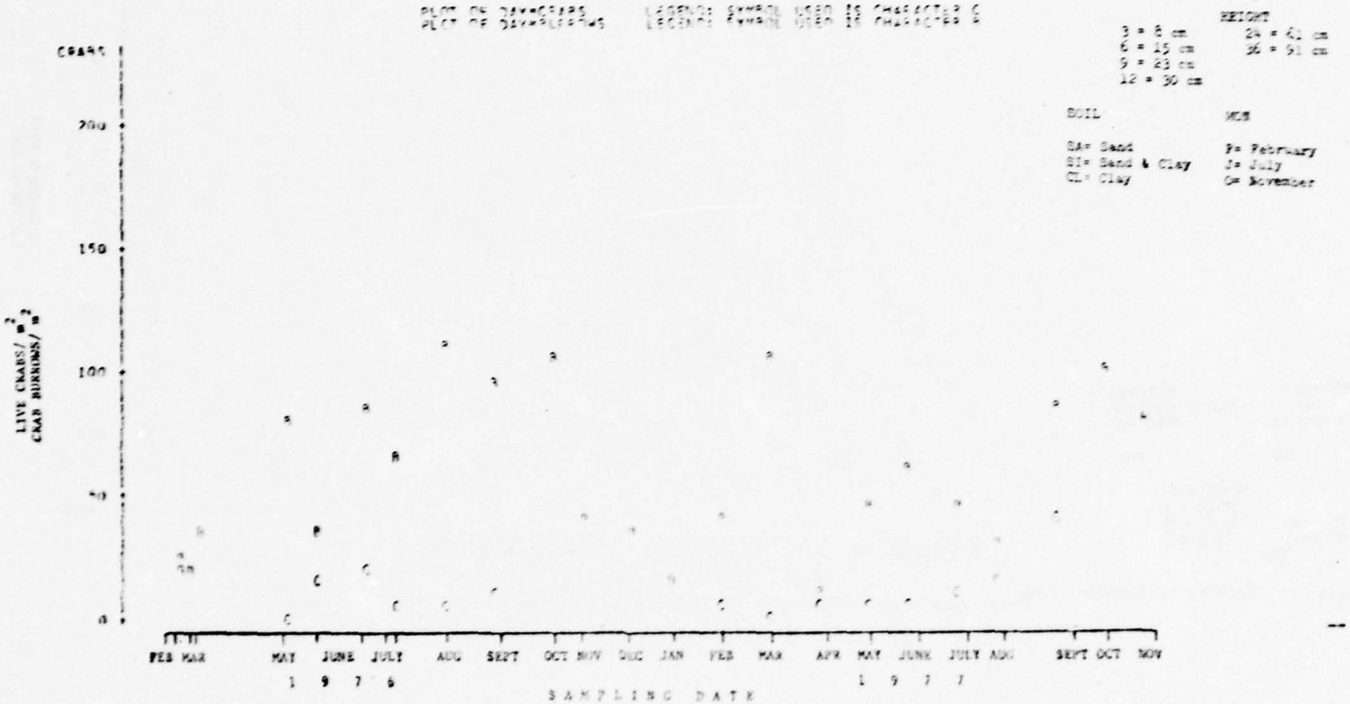
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

MON
F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 56
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=3 SOIL=CL MON=F

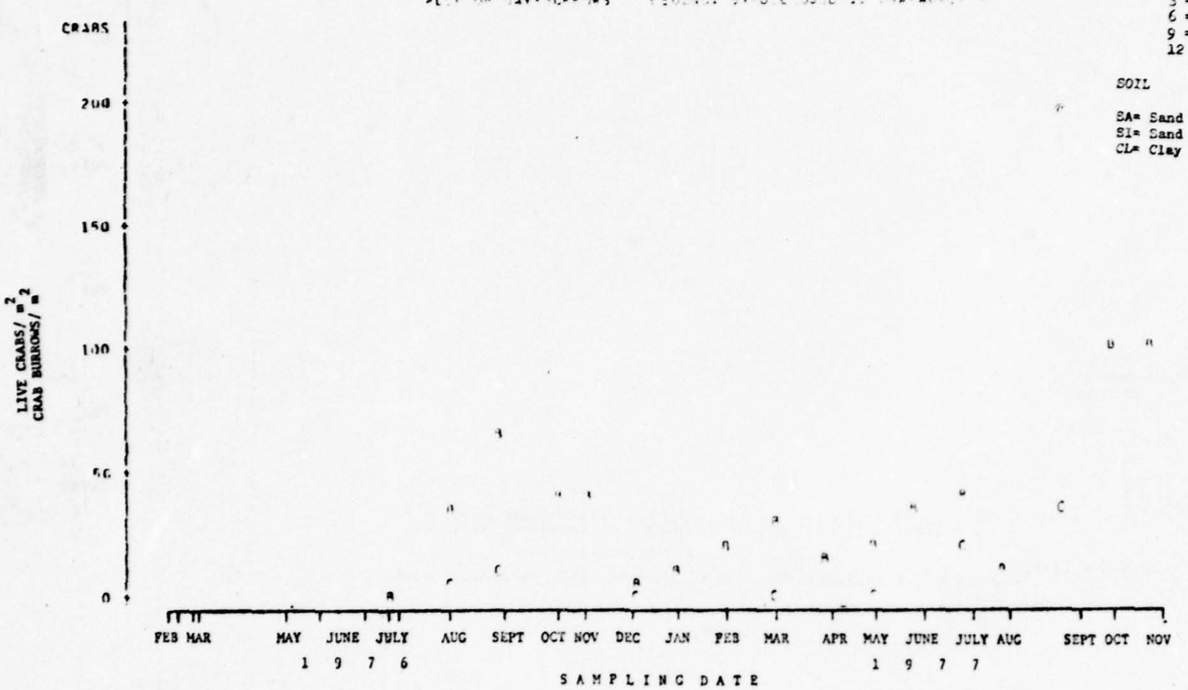
PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 57

HEIGHT=3 SOIL=CL MON=J

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

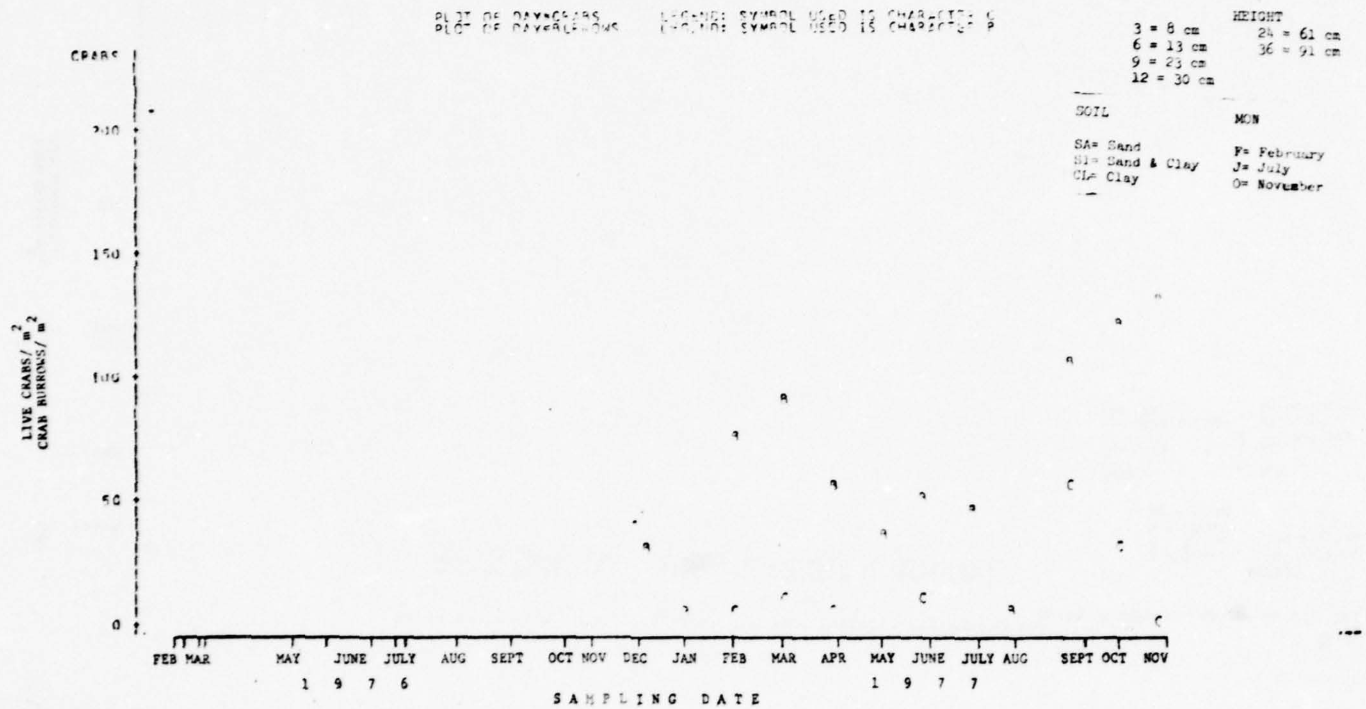
MON

F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 58

HEIGHT=3 SOIL=CL MON=O

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 59

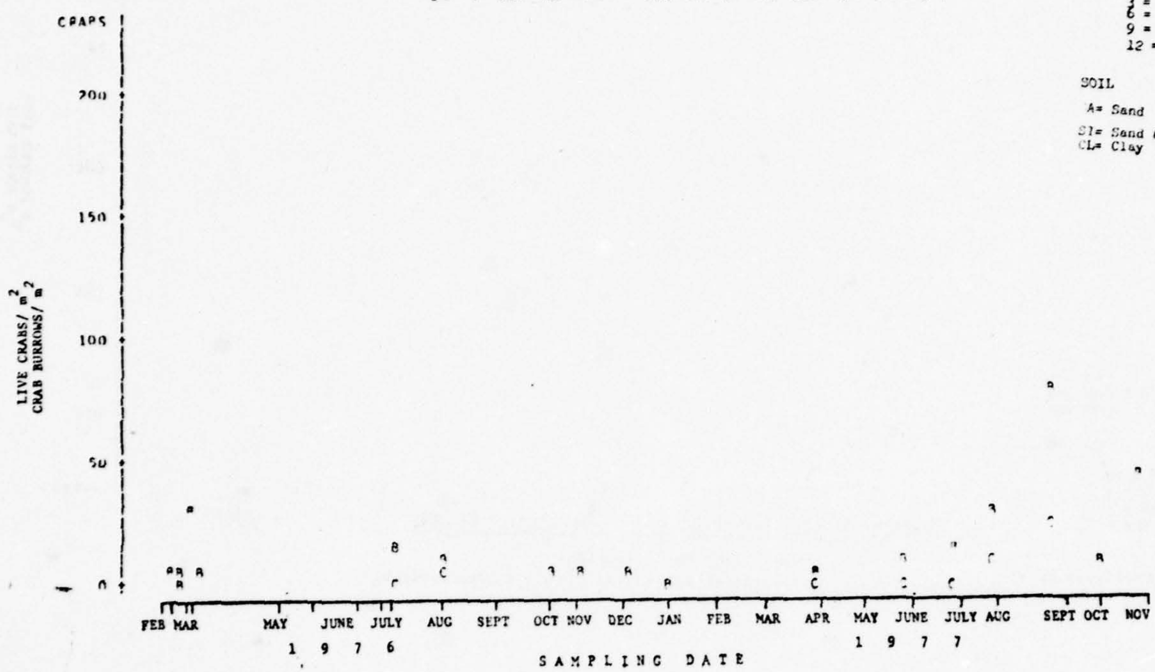
HEIGHT=3 SOIL=SA MON=F

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL
A= Sand
SI= Sand & Clay
CL= Clay

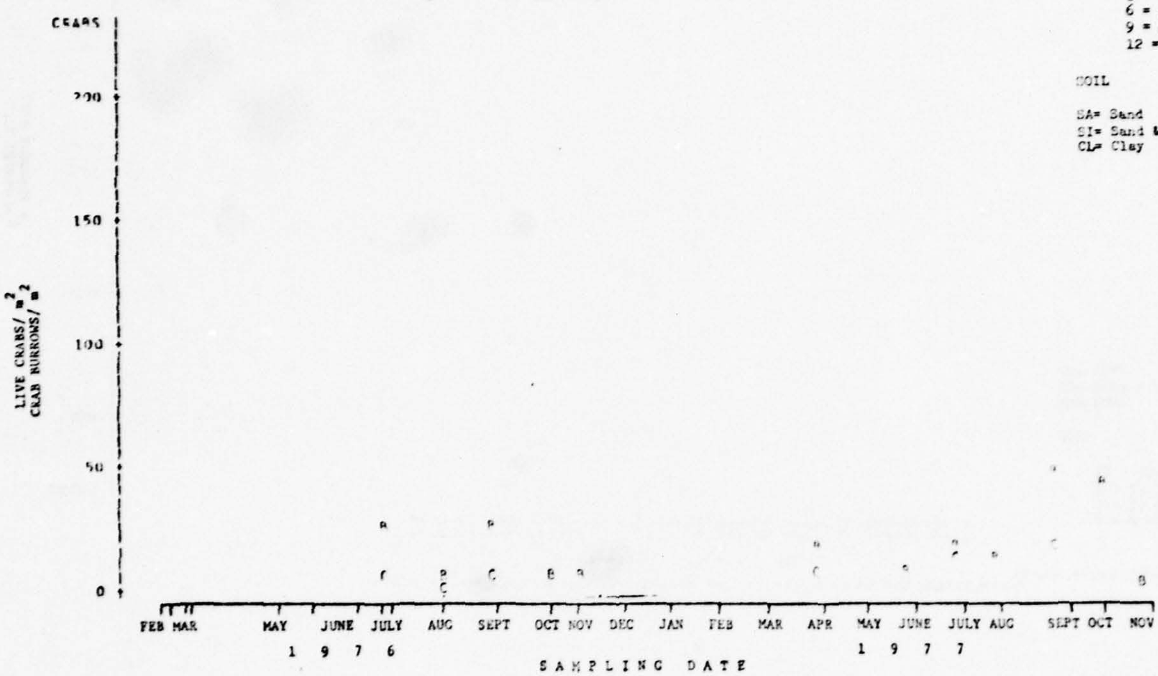
MON
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 60

HEIGHT=3 SOIL=SA MON=J

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

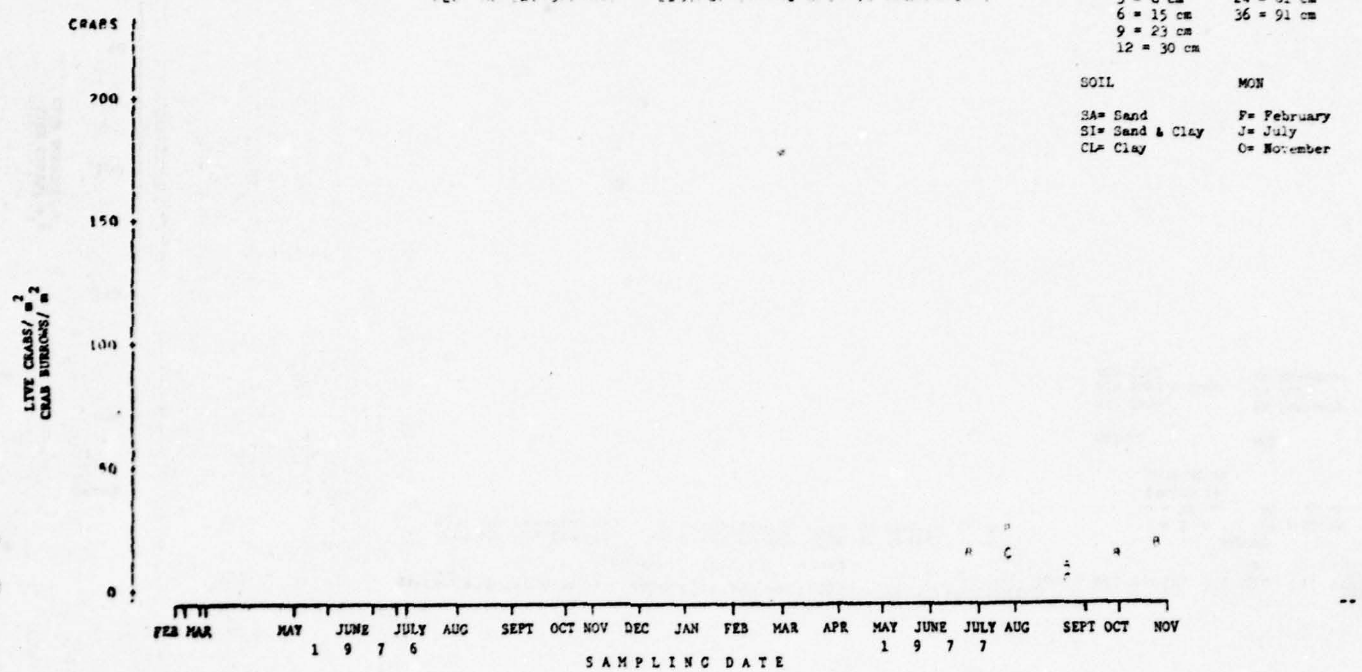
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

MON
F= February
J= July
O= November

MARSH ENGINEERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:33 WEDNESDAY, DECEMBER 21, 1977 61

HEIGHT=3 SOIL=SA MON=J

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



HEIGHT	
3 = 8 cm	24 = 61 cm
6 = 15 cm	36 = 91 cm
9 = 23 cm	
12 = 30 cm	

SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 62

HEIGHT=3 SOIL=SI MON=F

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT

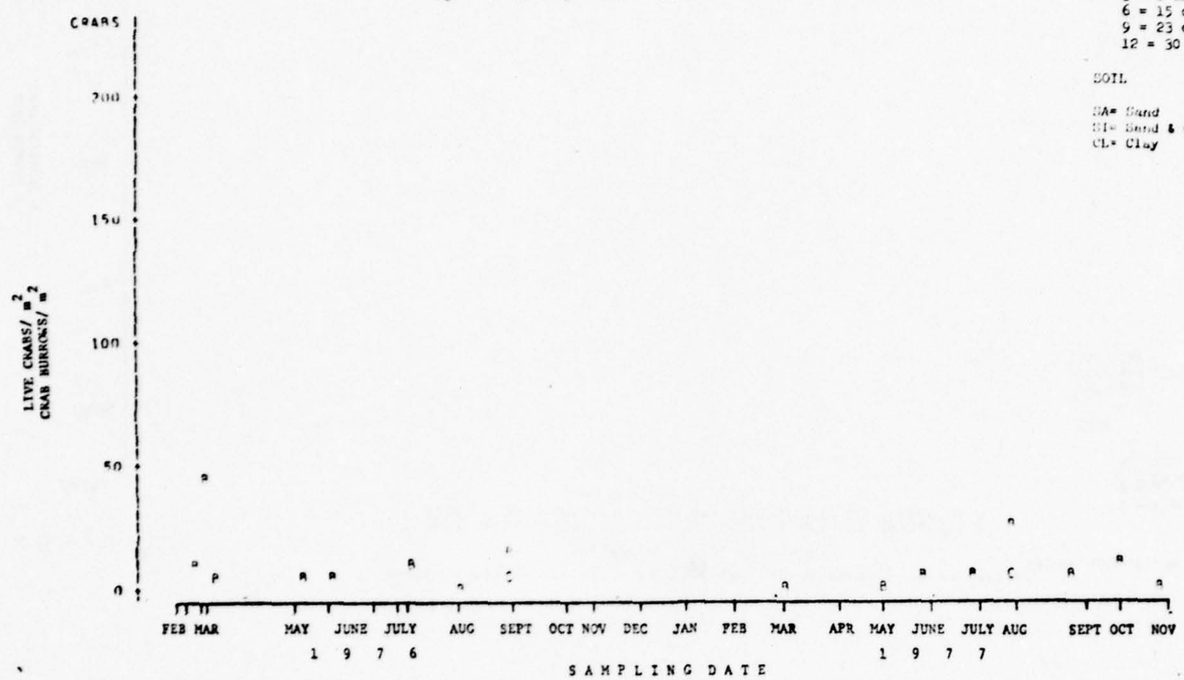
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 63

HEIGHT=3 SOIL=SI MON=J

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT

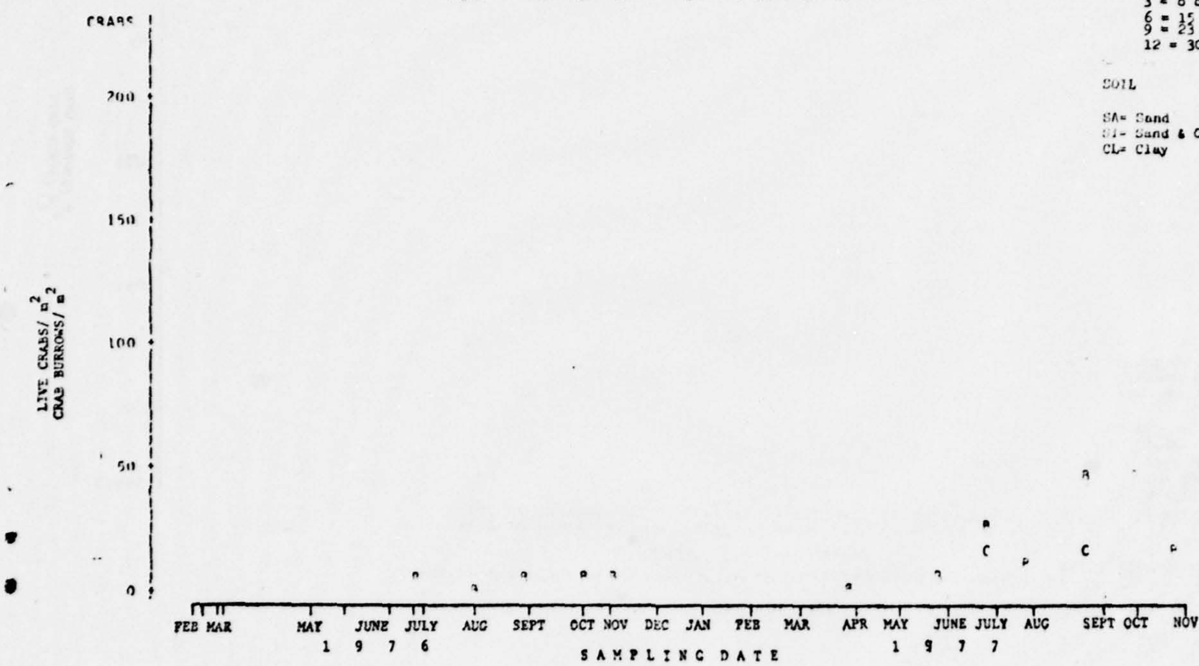
3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 30 cm

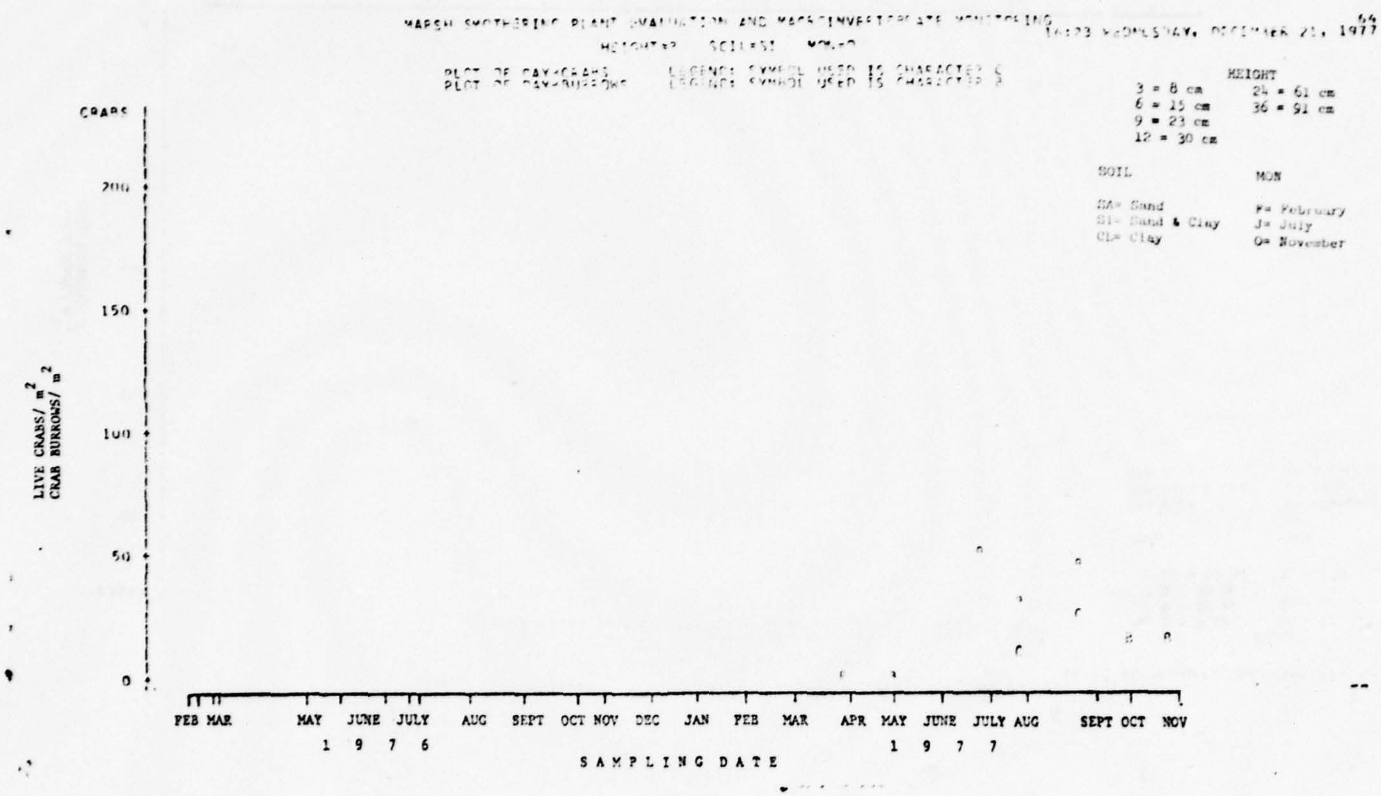
SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

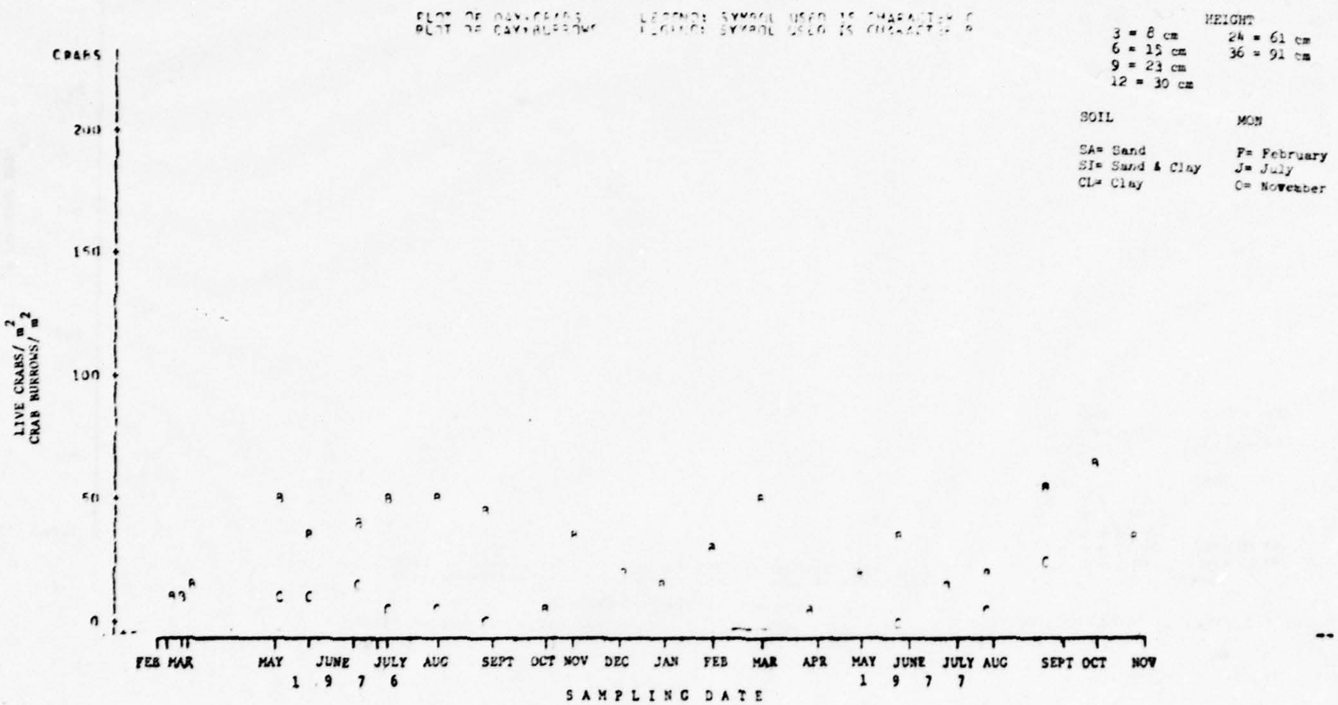



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING
14:23 WEDNESDAY, DECEMBER 21, 1977
64
HEIGHT=3 SOIL=SI MON=O
PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B
HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay
MON
F= February
J= July
O= November
CRABS
LIVE CRABS/ m2
CRAB BURROWS/ m2
200
150
100
50
0
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:22 WEDNESDAY, DECEMBER 21, 1977 65

HEIGHT=6 SOIL=CL MON=F

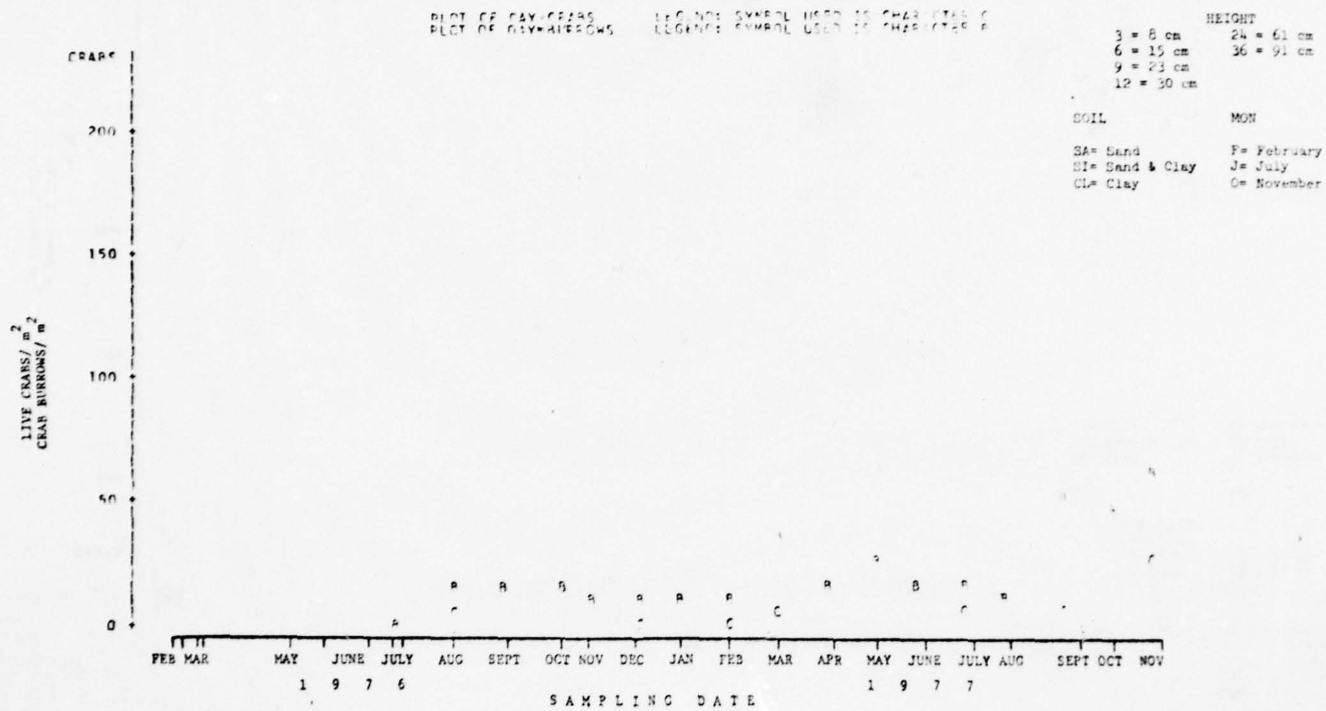
PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:33 THURSDAY, DECEMBER 21, 1977 66

HEIGHT=X SOIL=CL MON=J

PLOT OF CAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING
16:22 WEDNESDAY, DECEMBER 21, 1977 67

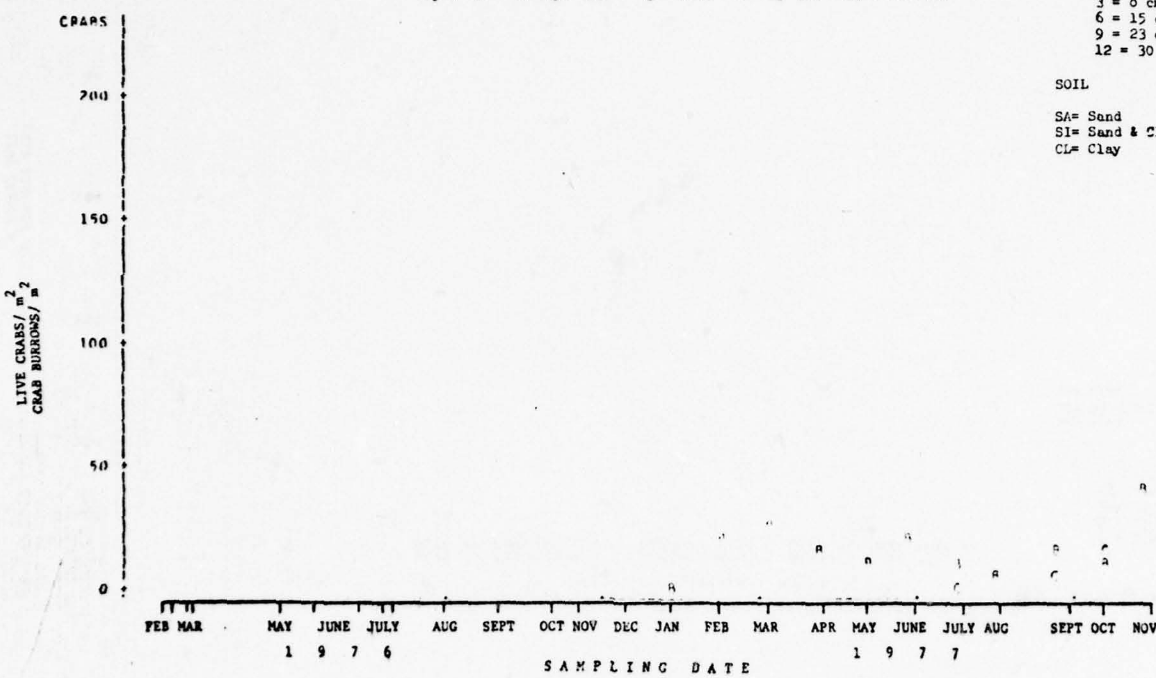
HEIGHT=. SOIL=CL MON=.

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

MON
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 68
14:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=6 SOIL=SA MON=F

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT

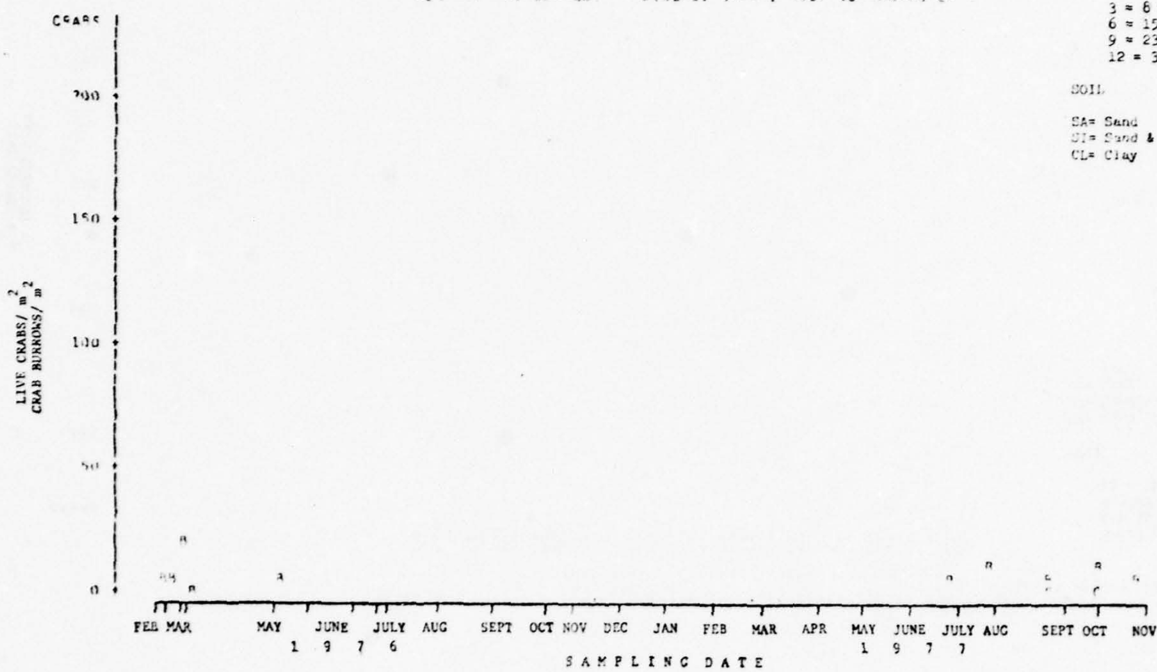
3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 30 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 69

[illegible] 21, 1977

HEIGHT=[illegible] SOIL=SA MON=[illegible]

PLOT OF DAY CRABS LEGEND: SYMBOL USED IS CHARACTER [illegible]
PLOT OF DAY BURROWS LEGEND: SYMBOL USED IS CHARACTER [illegible]

HEIGHT

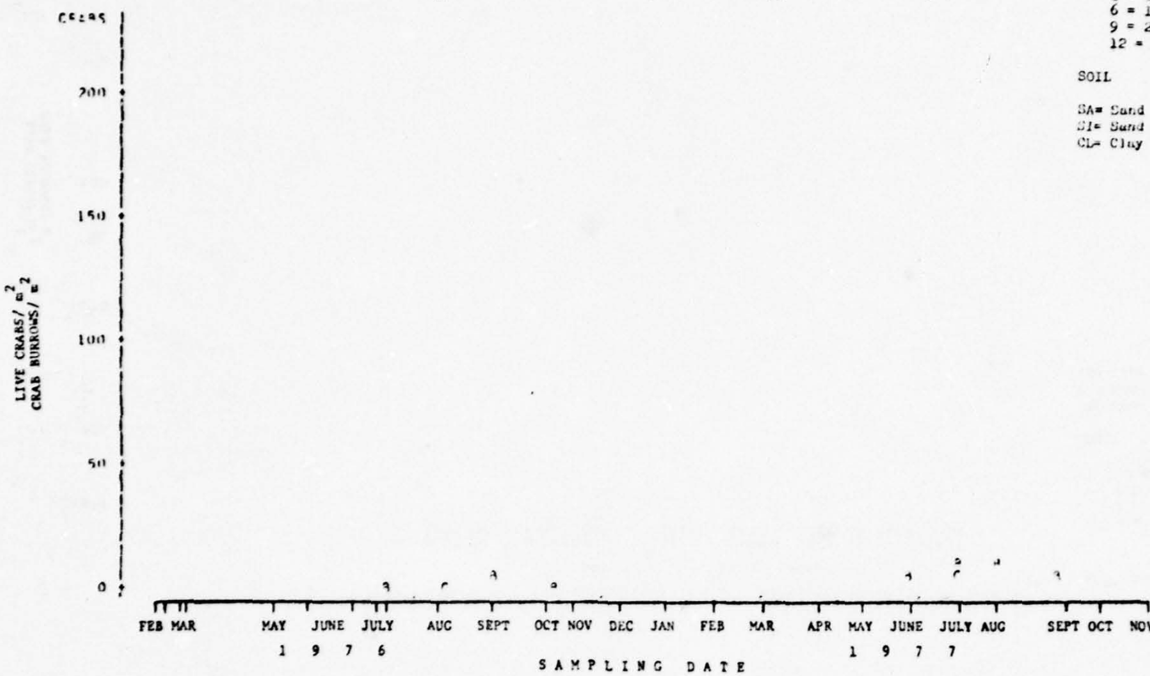
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 70
16:23 WEDNESDAY, DECEMBER 21, 1977

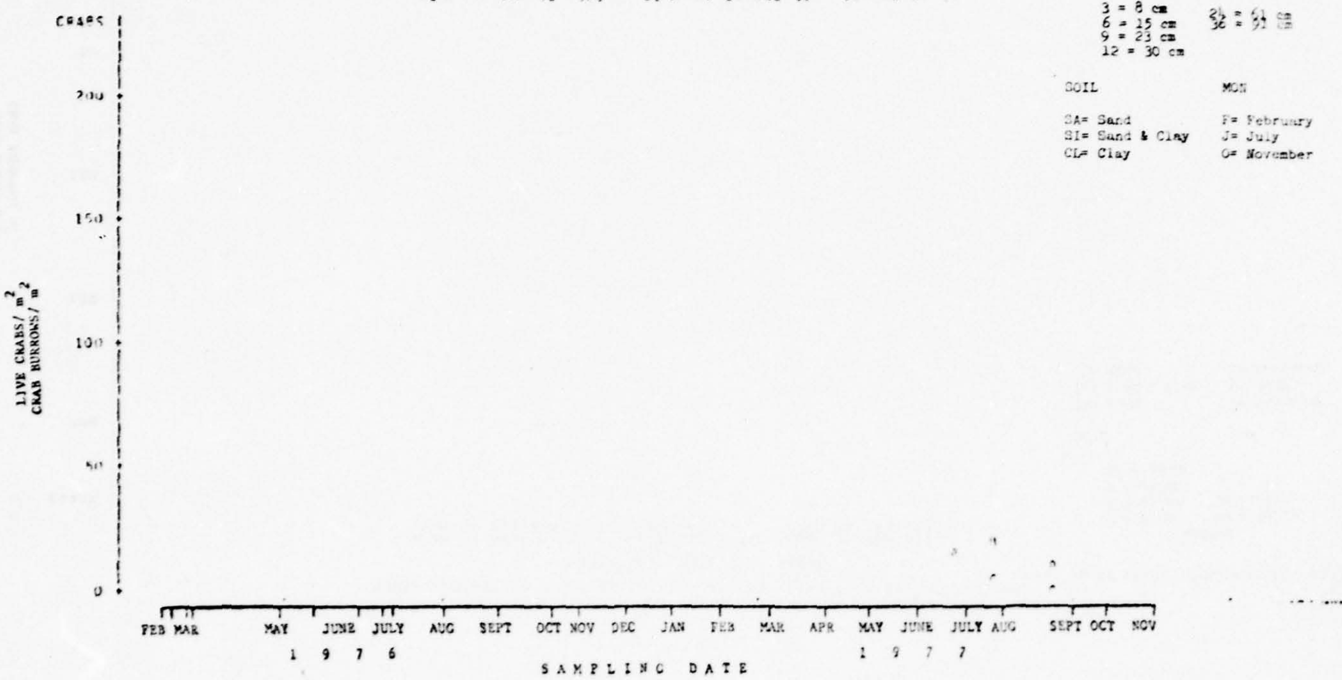
HEIGHT=6 SOIL=SA MON=O

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

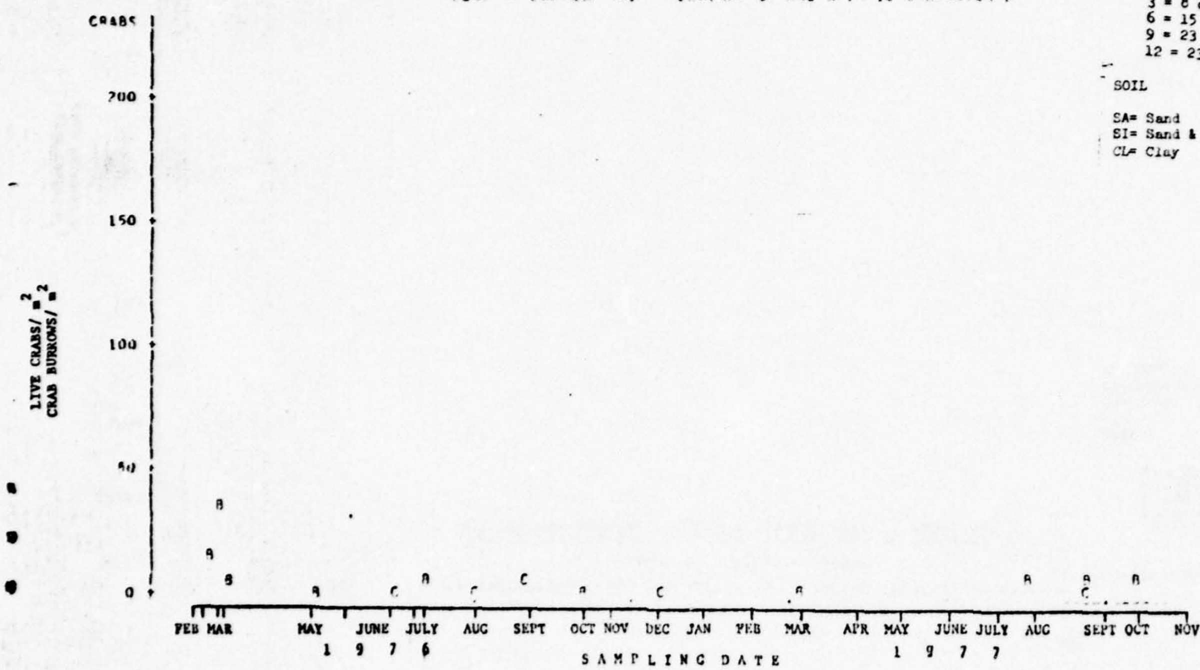
SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 71
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=6 SOIL=SI MON=F

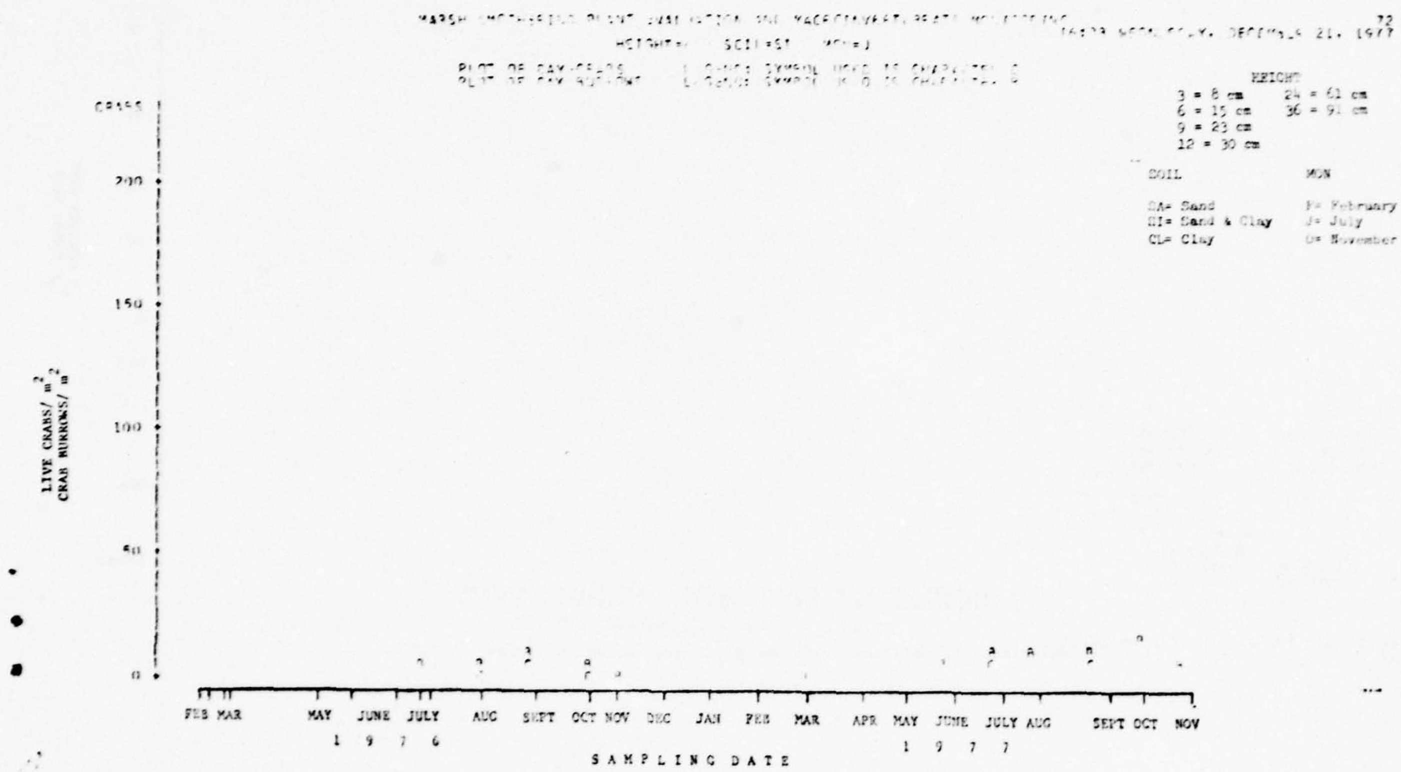
PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



HEIGHT
3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 23 cm

SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

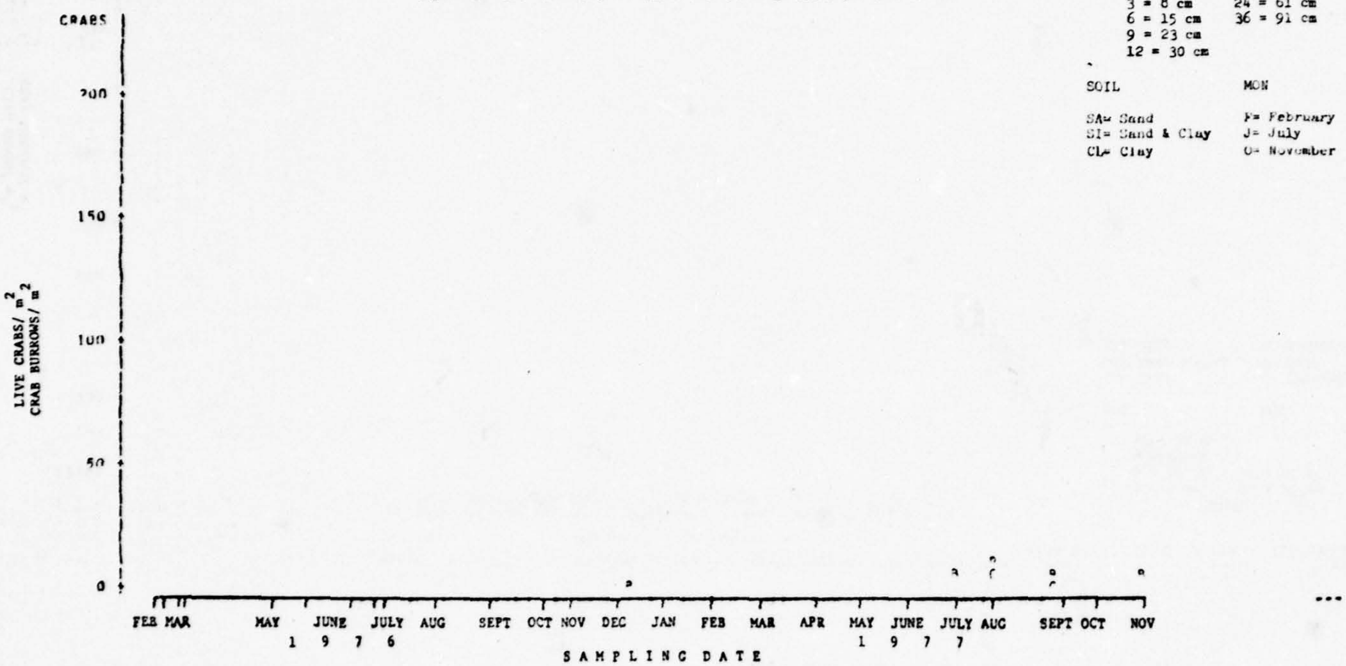
MON
F= February
J= July
O= November

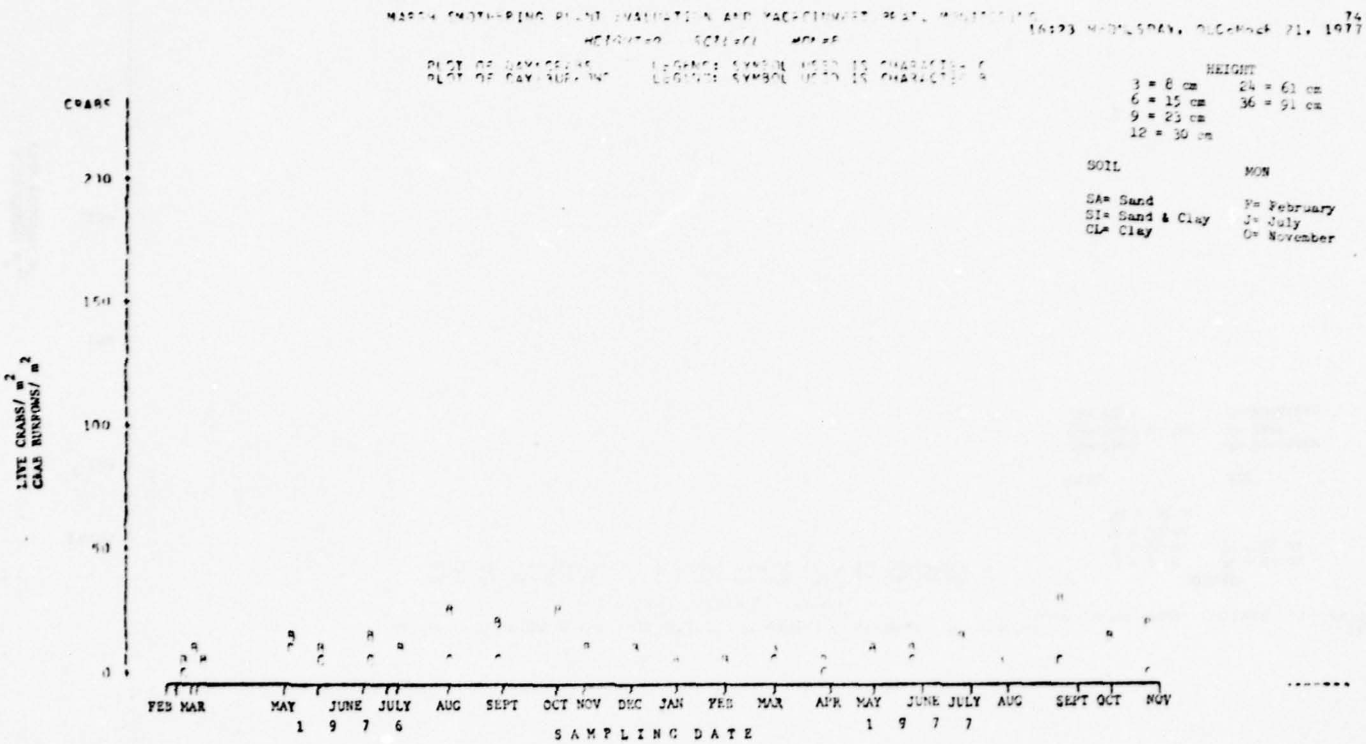

HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay
MON
F= February
J= July
N= November
LIVE CRABS/ m^2
CRAB BURROWS/ m^2
200
150
100
50
0
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 73

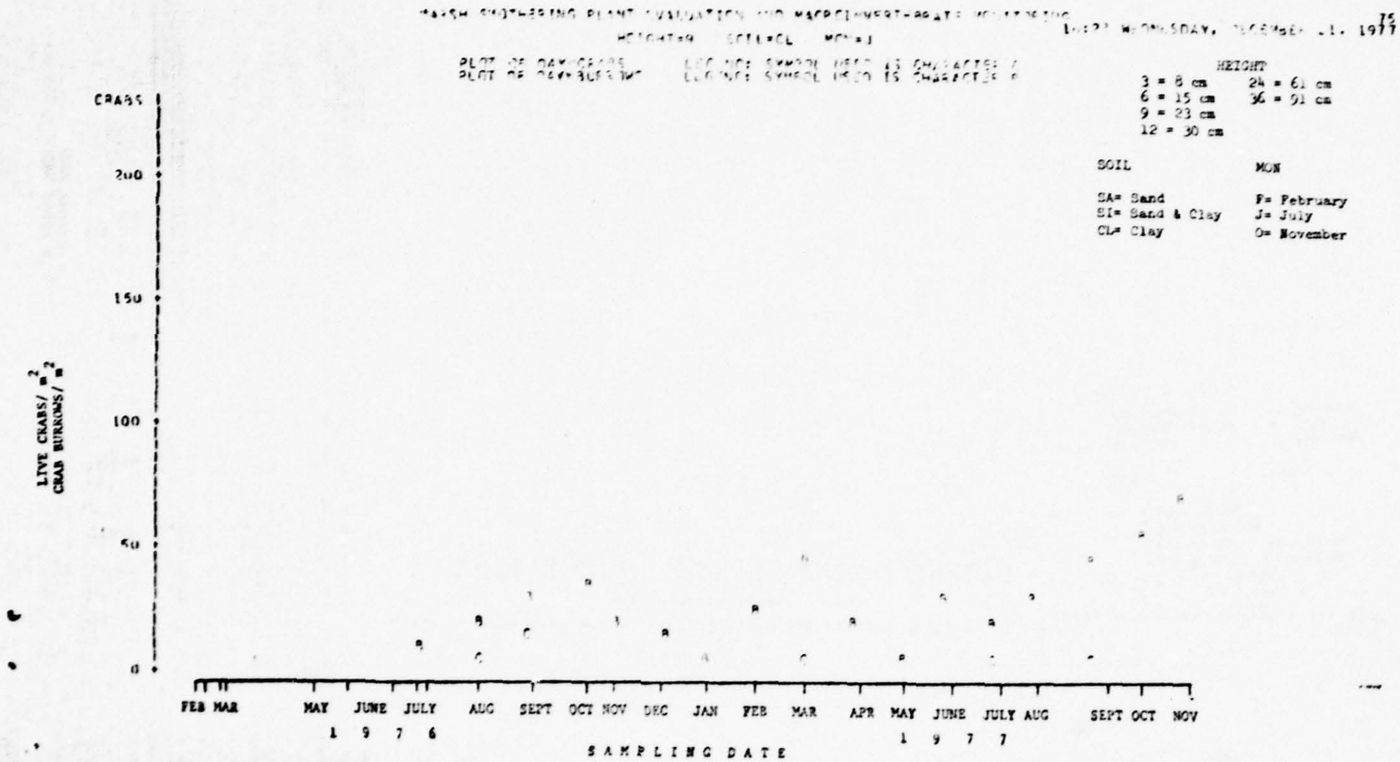
HEIGHT=6 SOIL=SI MON=O

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



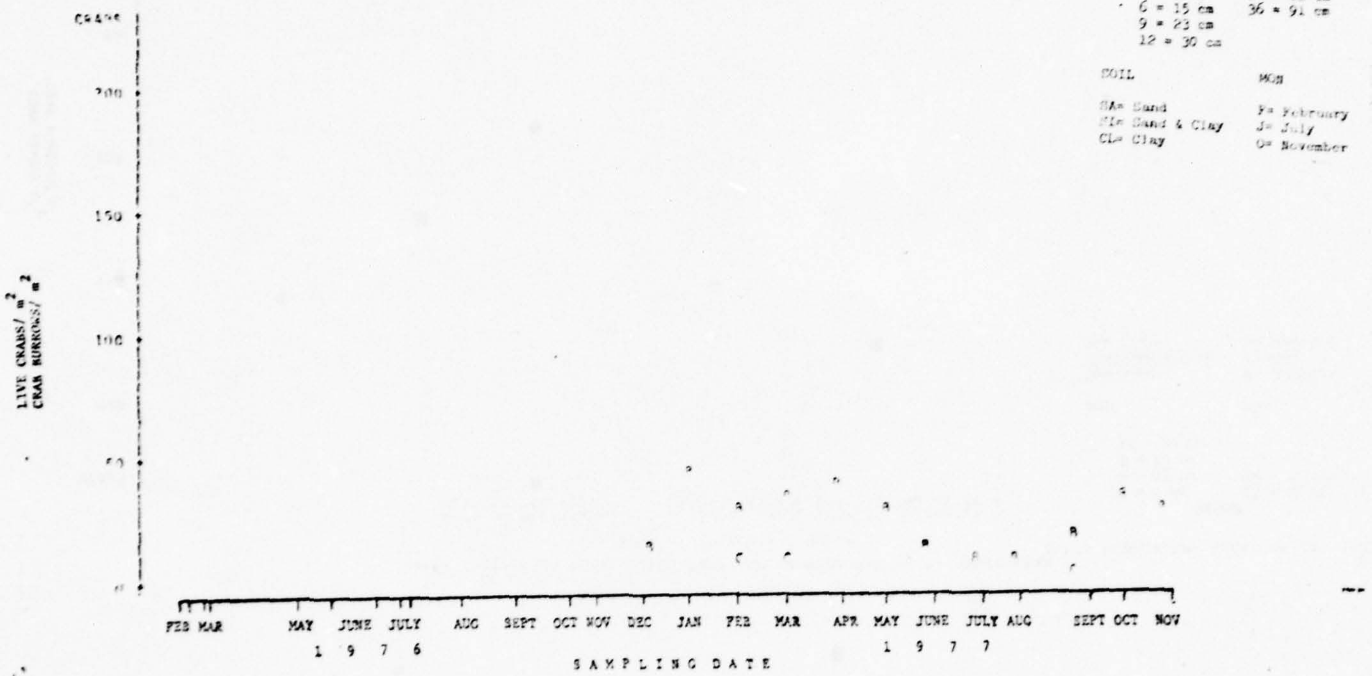


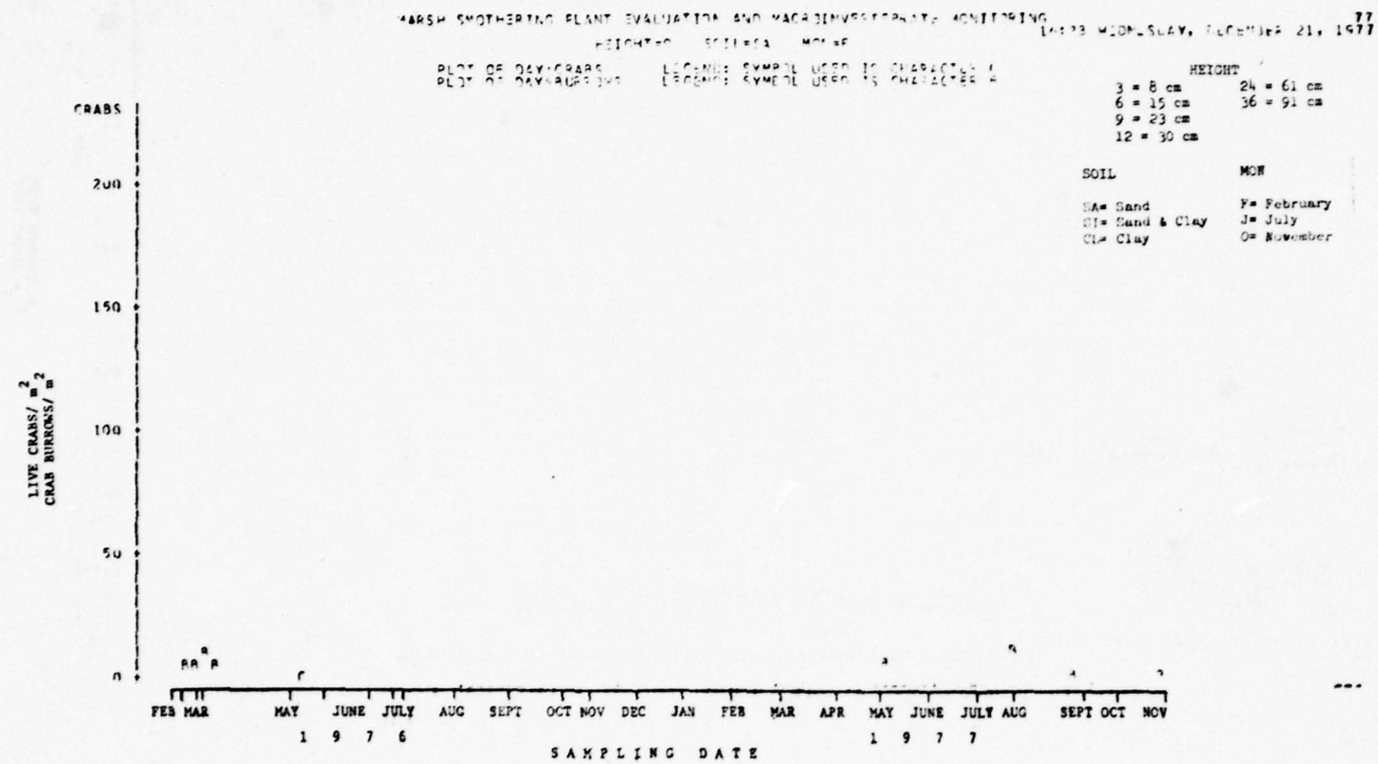
74
HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay
MON
F= February
J= July
O= November
CRABS
LIVE CRABS/ m2
CRAB BURROWS/ m2
0
50
100
150
210
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE


MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING
WEDNESDAY, DECEMBER 21, 1977
75
PLOT OF DAY*CRABS
PLOT OF DAY*BURROWS
HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay
MON
F= February
J= July
O= November
CRABS
200
150
100
50
0
LIVE CRABS/ m2
CRAB BURROWS/ m2
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE

MARSH ESTABLISHING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 76

PLOT OF DAY*CRABS   LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS   LEGEND: SYMBOL USED IS CHARACTER B




MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING
77
DECEMBER 21, 1977
PLOT OF DAY*CRABS
HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay
MON
F= February
J= July
O= November
CRABS
LIVE CRABS/ m2
CRAB BURROWS/ m2
200
150
100
50
0
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 76
[illegible] WEDNESDAY, DECEMBER 21, 1977

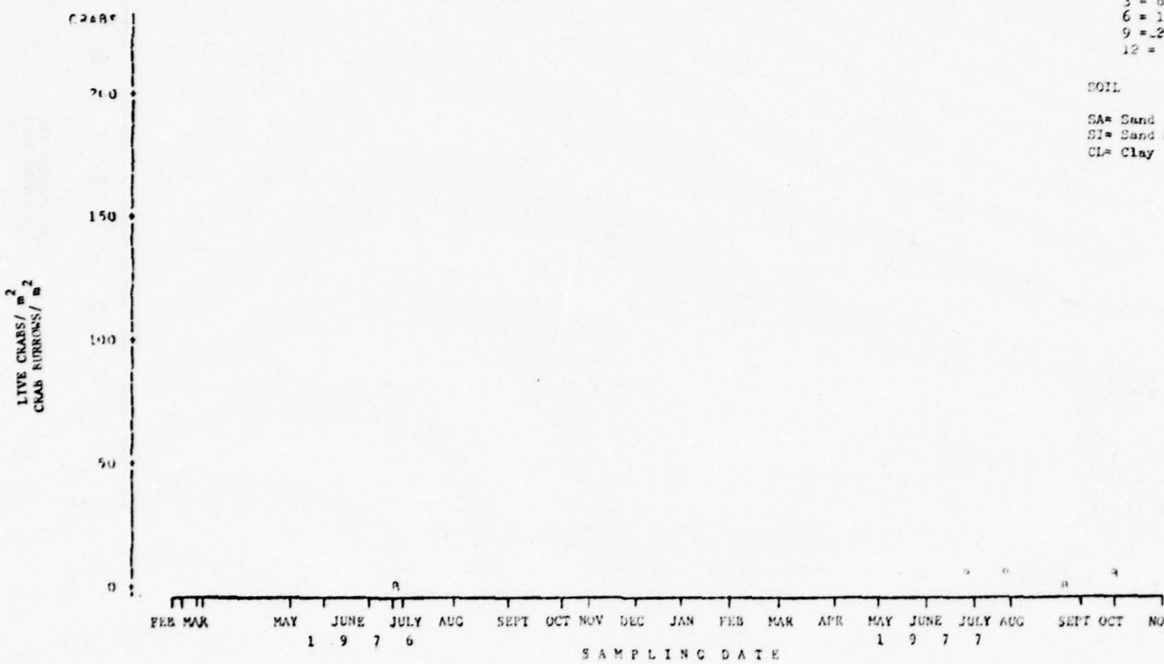
HEIGHT=0 SOIL=SA MON=J

PLOT OF DAY CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT

3 = 8 cm	24 = 61 cm
6 = 15 cm	36 = 91 cm
9 = 23 cm	
12 = 30 cm	

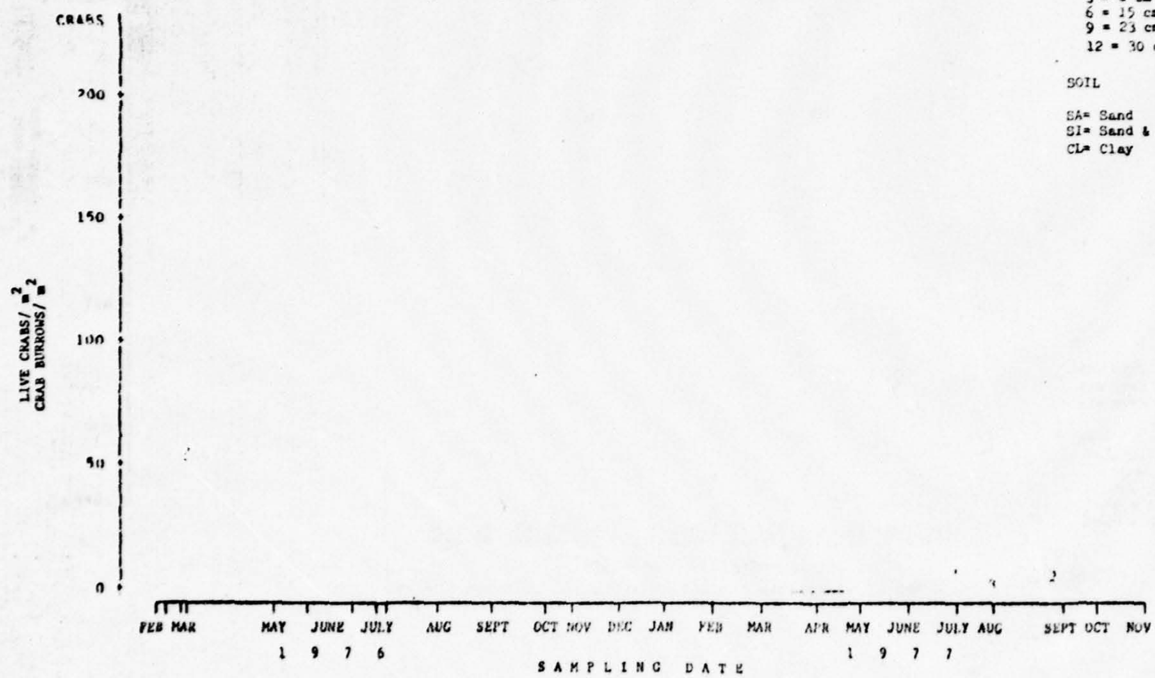
SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November



MARSH ESTABLISHING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 79
16:23 WEDNESDAY, DECEMBER 21, 1977

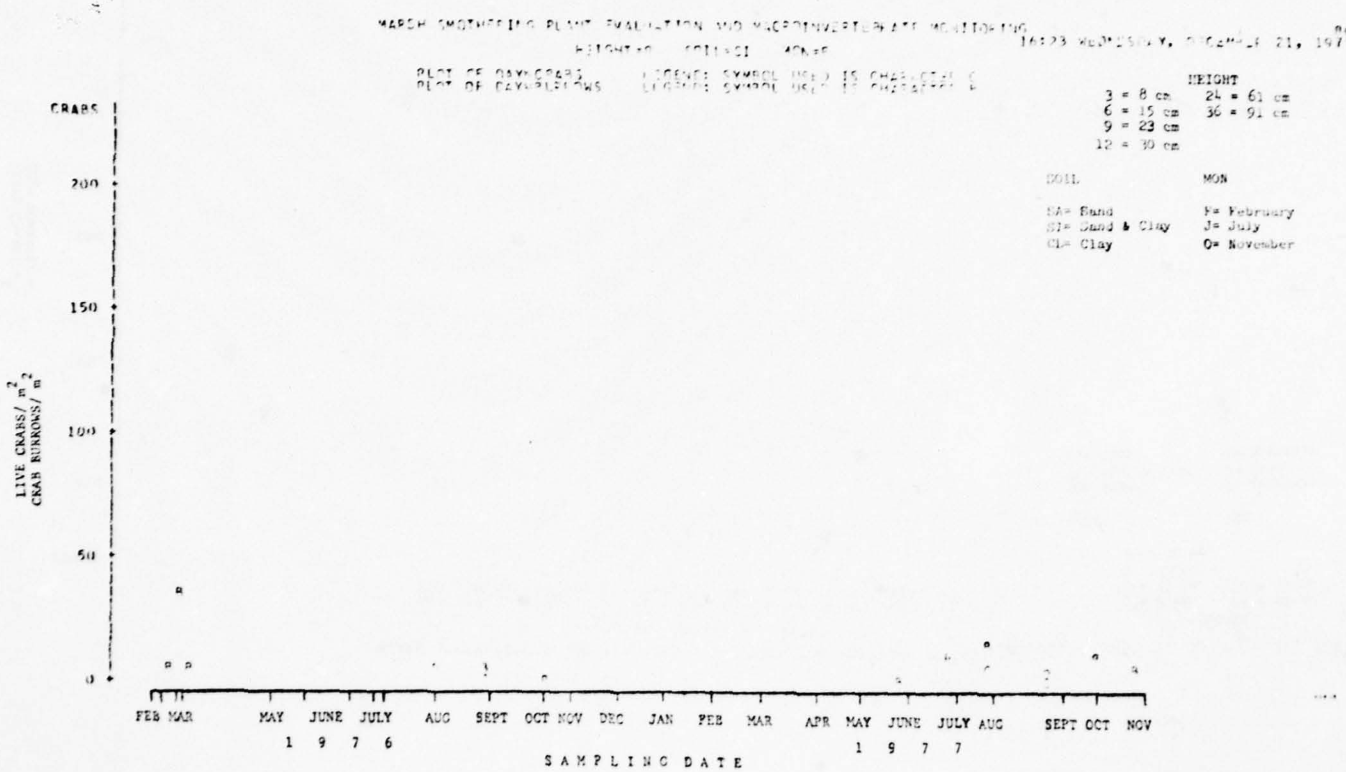
HEIGHT=9 SOIL=SI MON=O

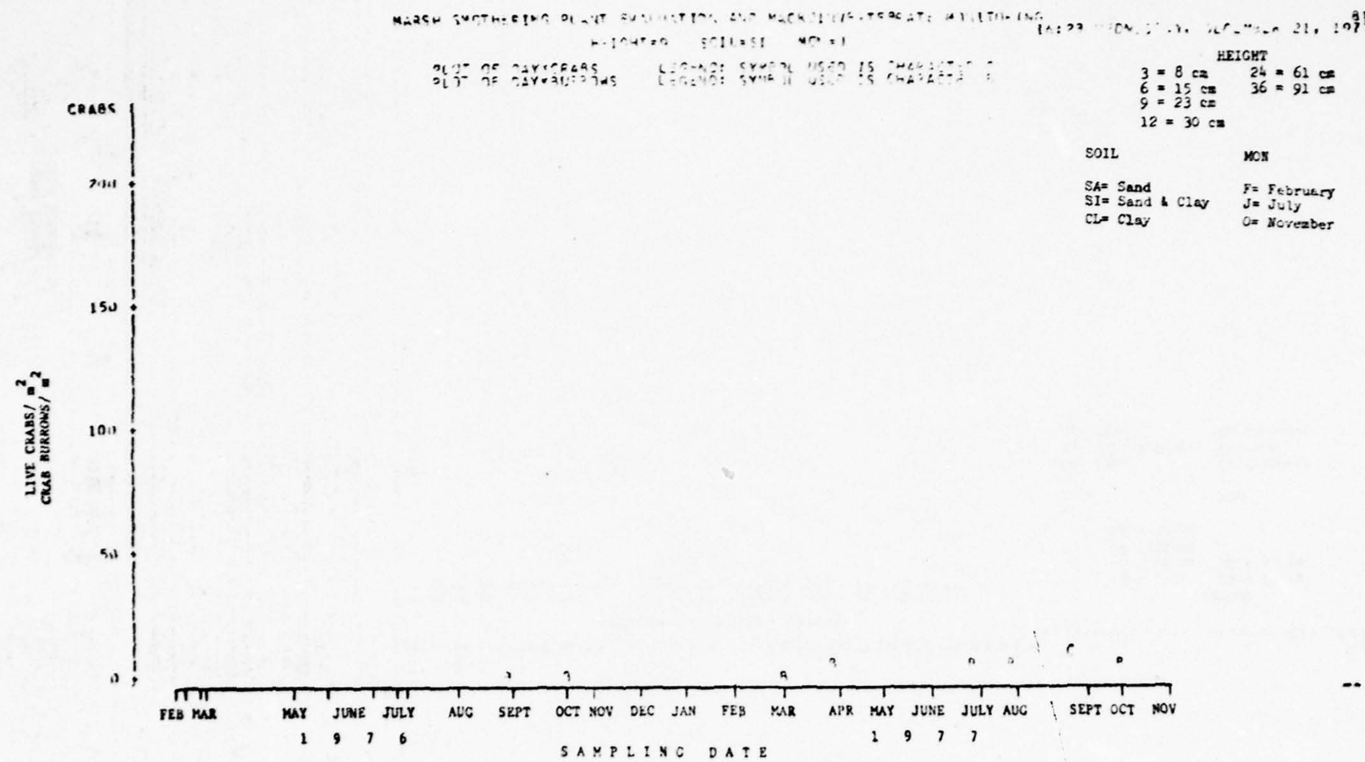
PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

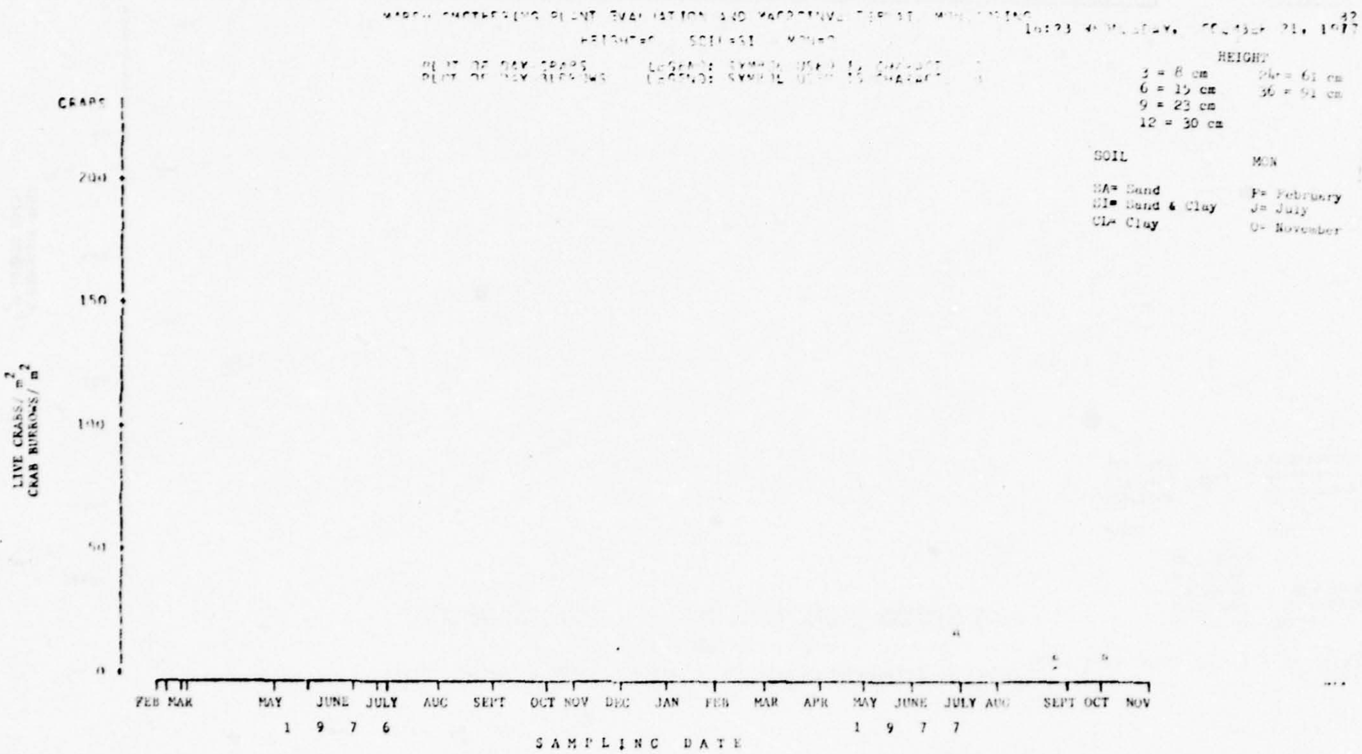


HEIGHT	
3 = 8 cm	24 = 61 cm
6 = 15 cm	36 = 91 cm
9 = 23 cm	
12 = 30 cm	

SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November


MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING
80
16:23 WEDNESDAY, DECEMBER 21, 1977
HEIGHT
3 = 8 cm
24 = 61 cm
6 = 15 cm
36 = 91 cm
9 = 23 cm
12 = 30 cm
SOIL
MON
SA= Sand
SI= Sand & Clay
CL= Clay
F= February
J= July
O= November
CRABS
200
150
100
50
0
LIVE CRABS/ m2
CRAB BURROWS/ m2
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE

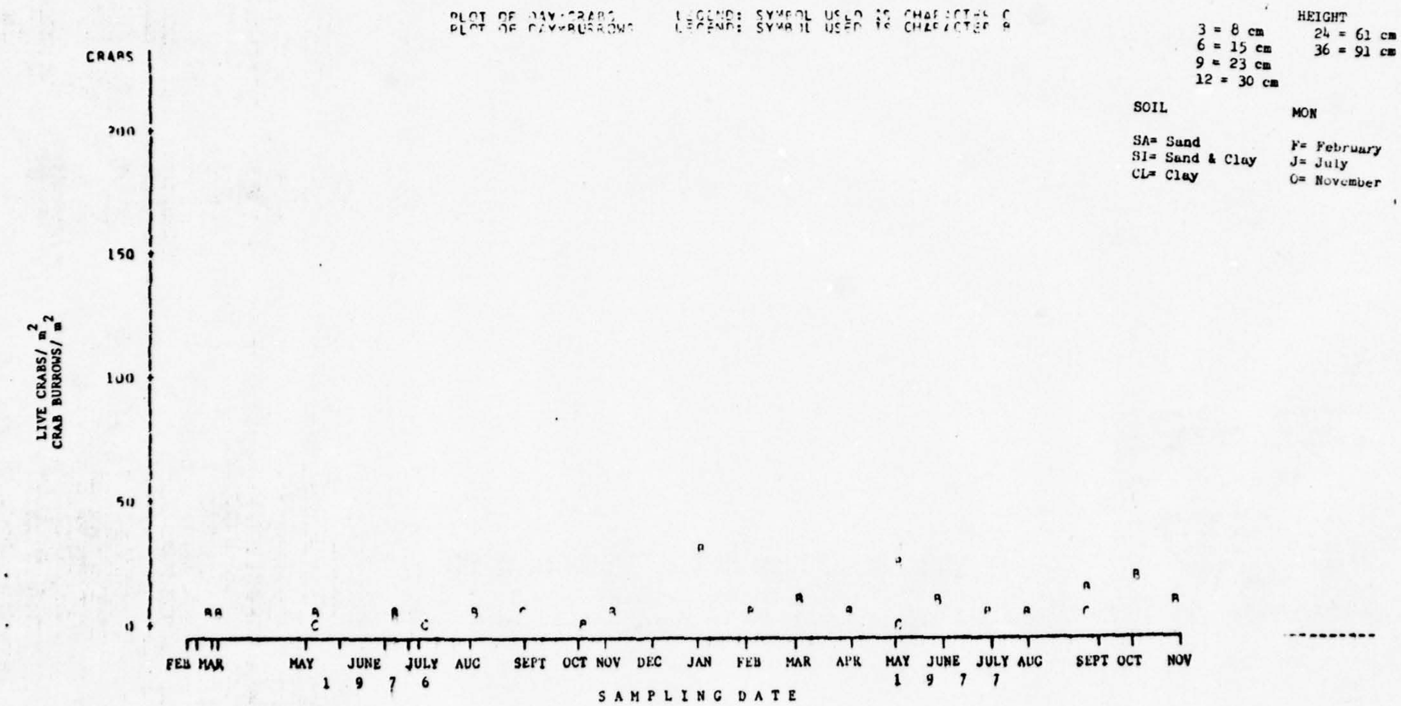

HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay
MON
F= February
J= July
O= November
CRABS
200
150
100
50
0
LIVE CRABS/ m2
CRAB BURROWS/ m2
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE

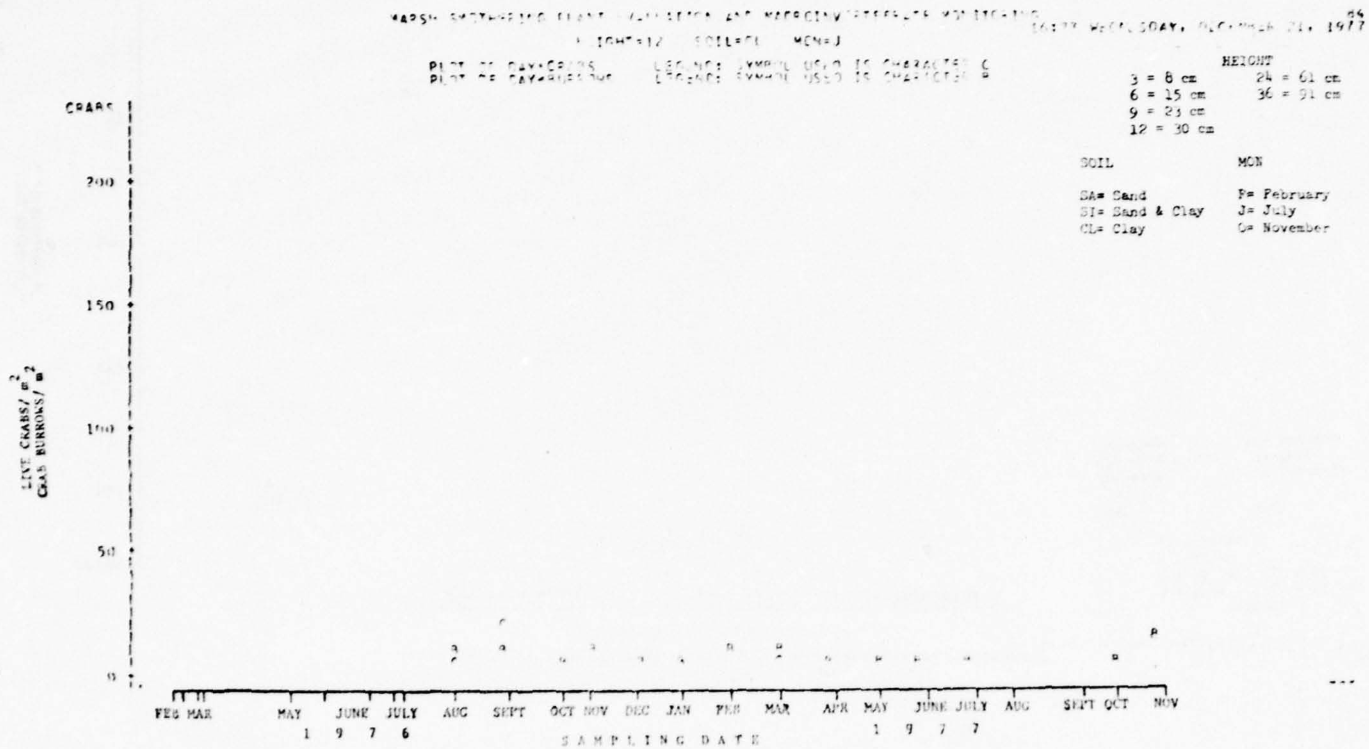

16:23 ... 21, 1977
HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay
MON
F= February
J= July
N= November
CRABS
200
150
100
50
0
LIVE CRABS/ m2
CRAB BURROWS/ m2
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 83

HEIGHT=12 SOIL=CL MON=F

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

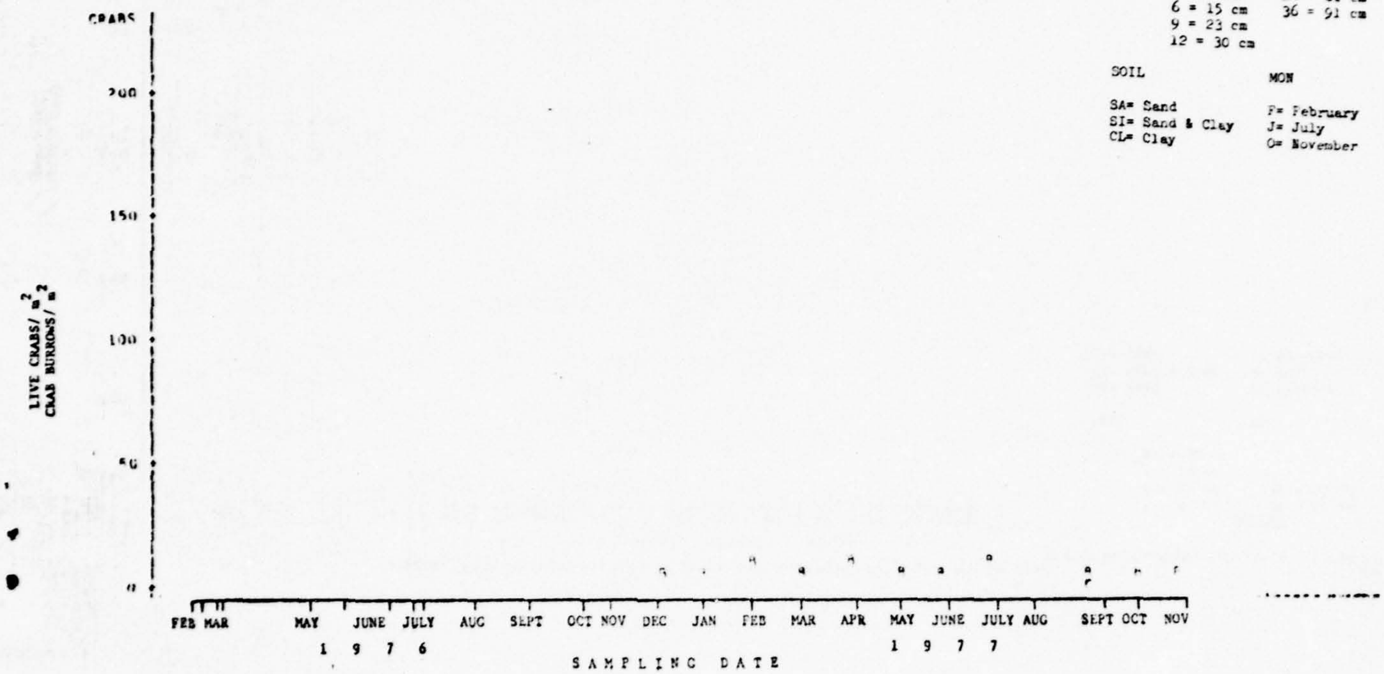



CRABS
200
150
100
50
0
LIVE CRABS/ m^2
CRAB BURROWS/ m^2
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE
HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay
MON
F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 10:23 WEDNESDAY, DECEMBER 21, 1977 95

HEIGHT=12 SOIL=CL MON=[illegible]

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 1:23 WEDNESDAY, DECEMBER 21, 1977 86

HEIGHT=12 SOIL=SA MON=F

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER P

HEIGHT

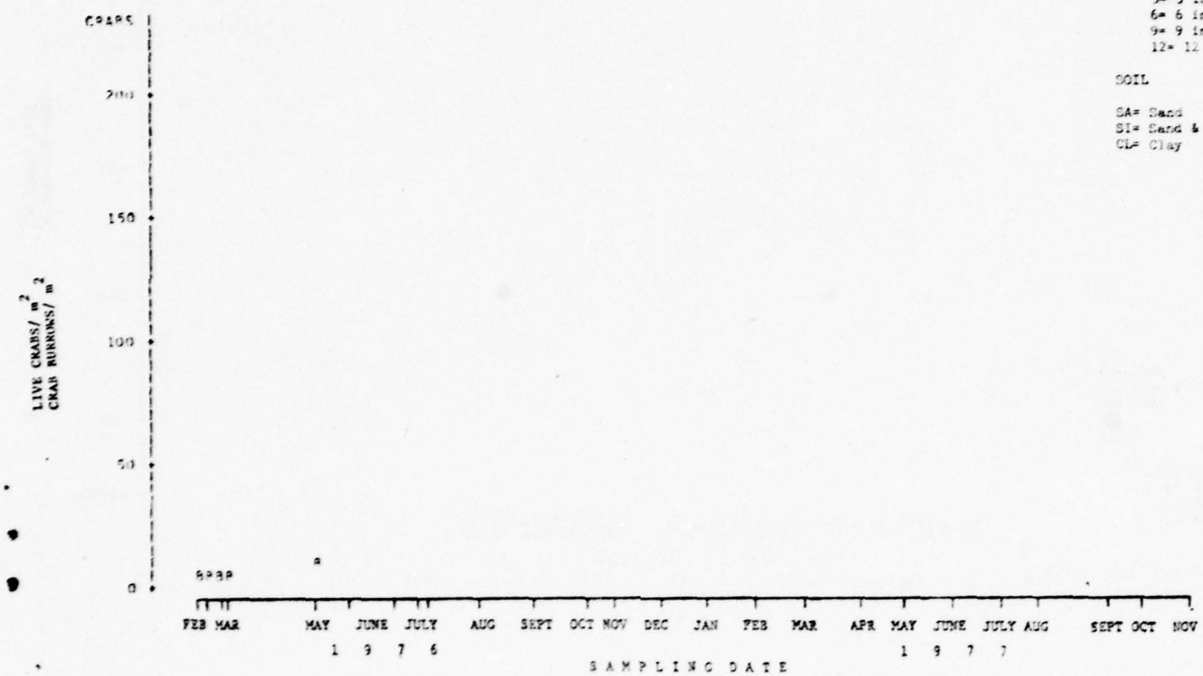
3= 3 inches 24= 24 inches
6= 6 inches 36= 36 inches
9= 9 inches
12= 12 inches

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 97
16:?? WEDNESDAY, DECEMBER 21, 1977

HEIGHT=12 SOIL=SA MON=J

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT

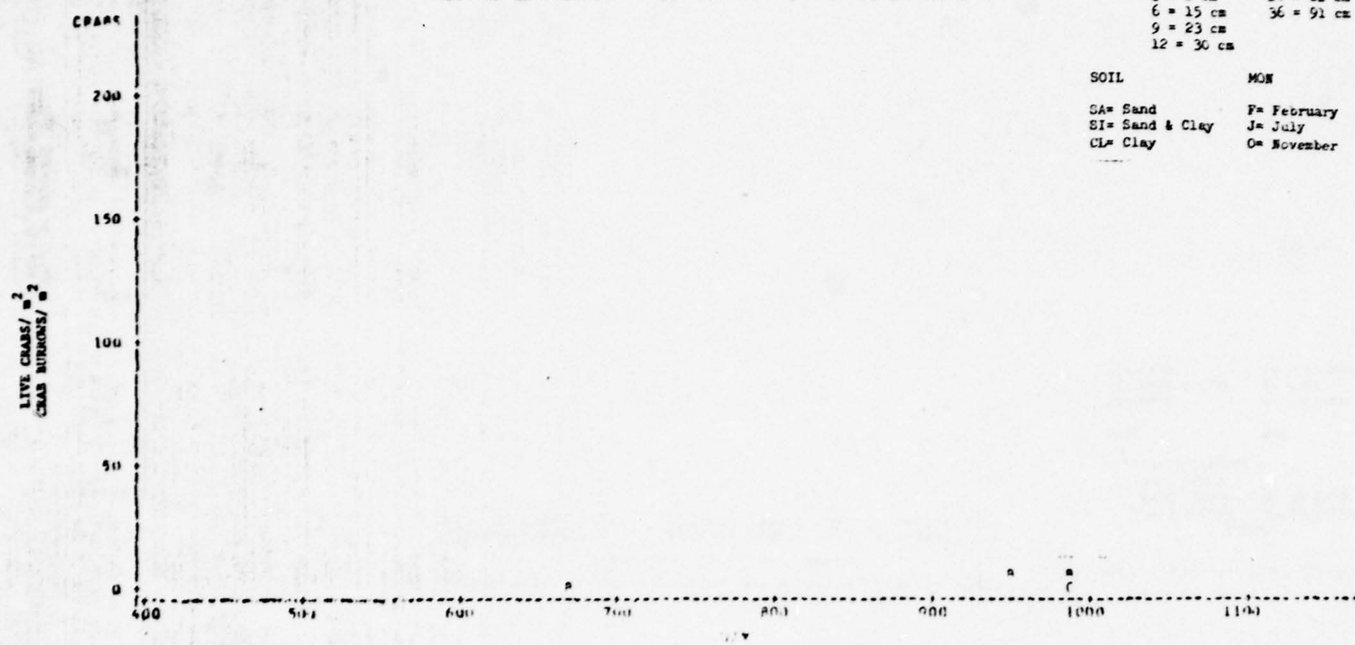
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 88

HEIGHT=12 SOIL=SA MON=O

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT

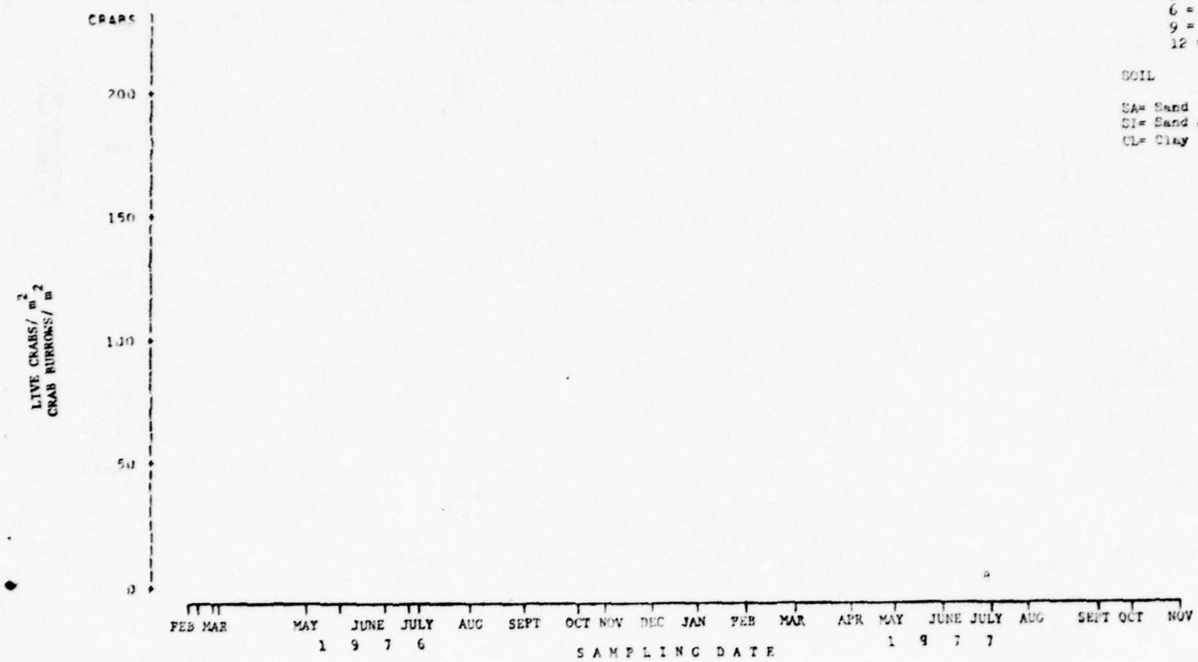
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



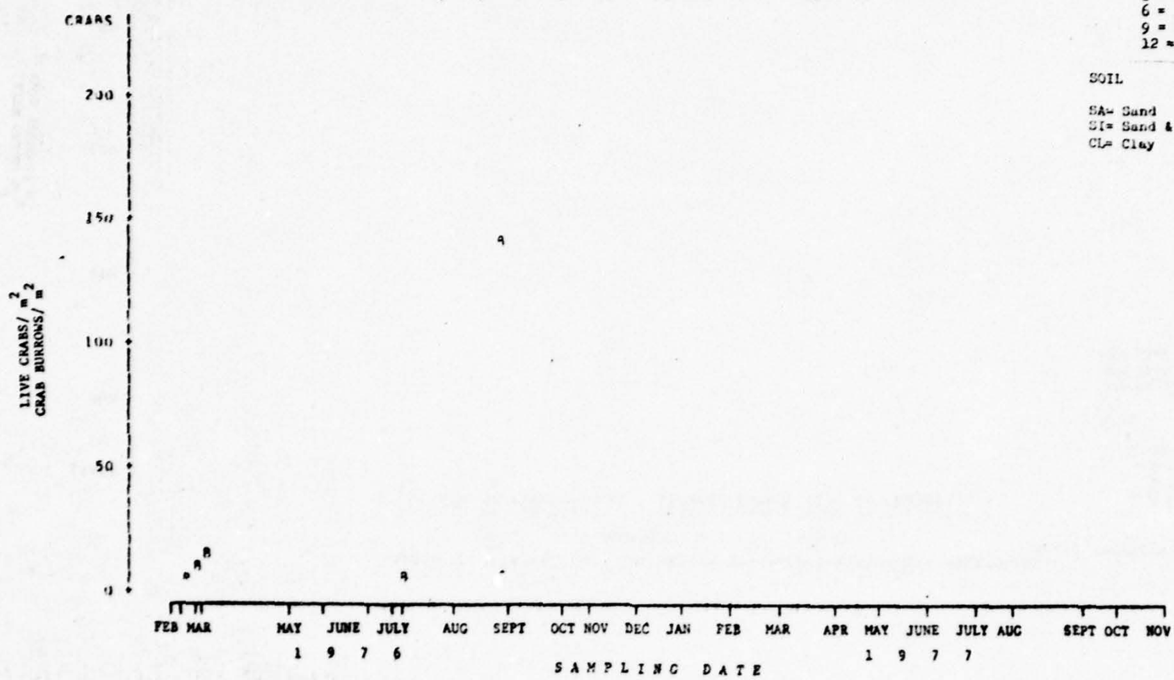
MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 89
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=12 SOIL=SI MON=F

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT	
3 = 8 cm	24 = 61 cm
6 = 15 cm	36 = 91 cm
9 = 23 cm	
12 = 30 cm	

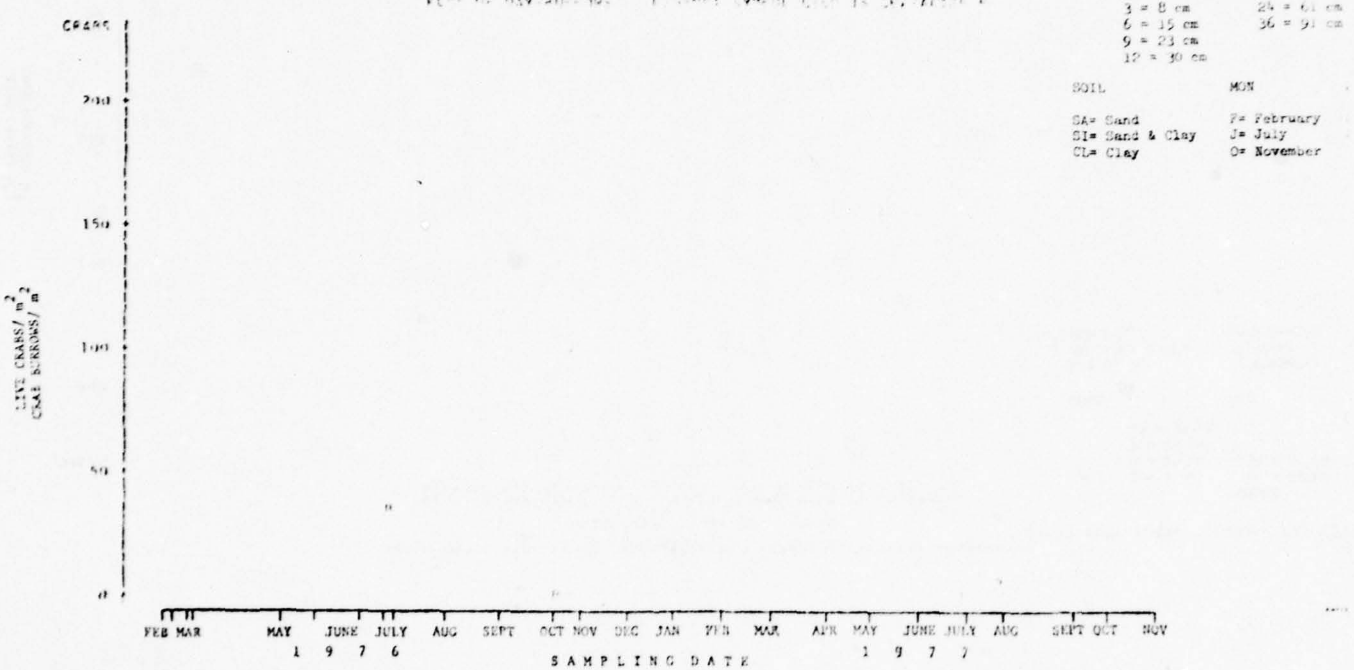
SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 90

HEIGHT=12 SOIL=SI MON=J

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS SYMBOL USED IS CHARACTER B



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING
14:23 WEDNESDAY, DECEMBER 21, 1977

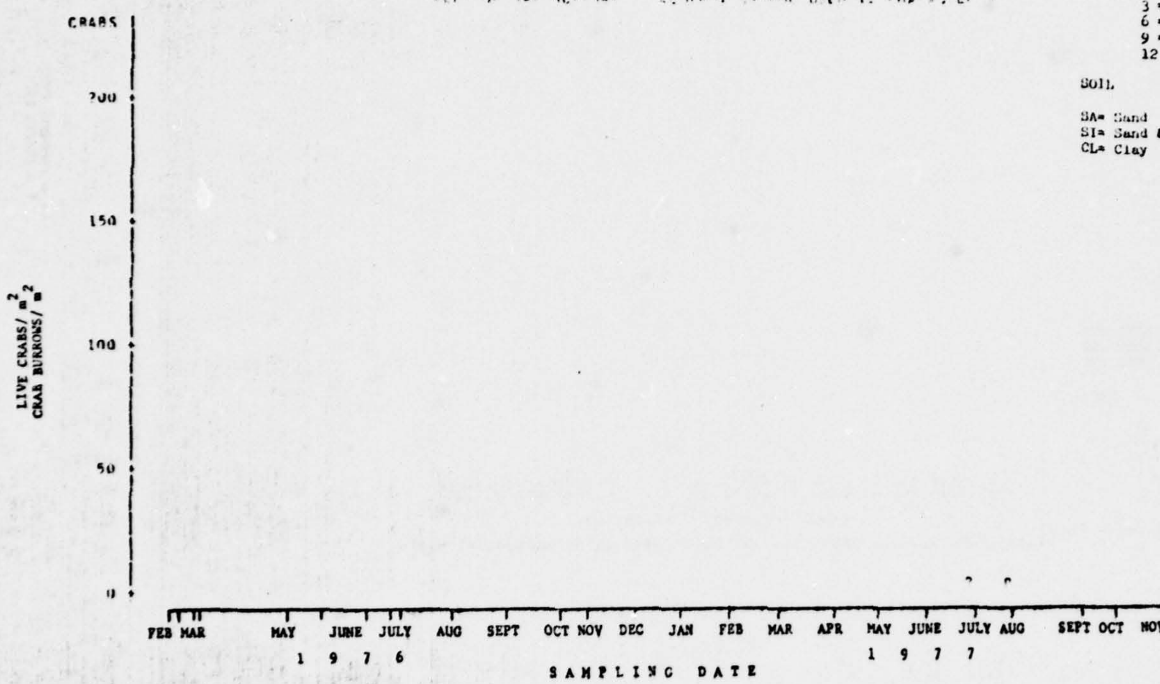
HEIGHT=12 SOIL=SI MON=O

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

MON
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 92

HEIGHT=24 SOIL=CL MON=F

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT

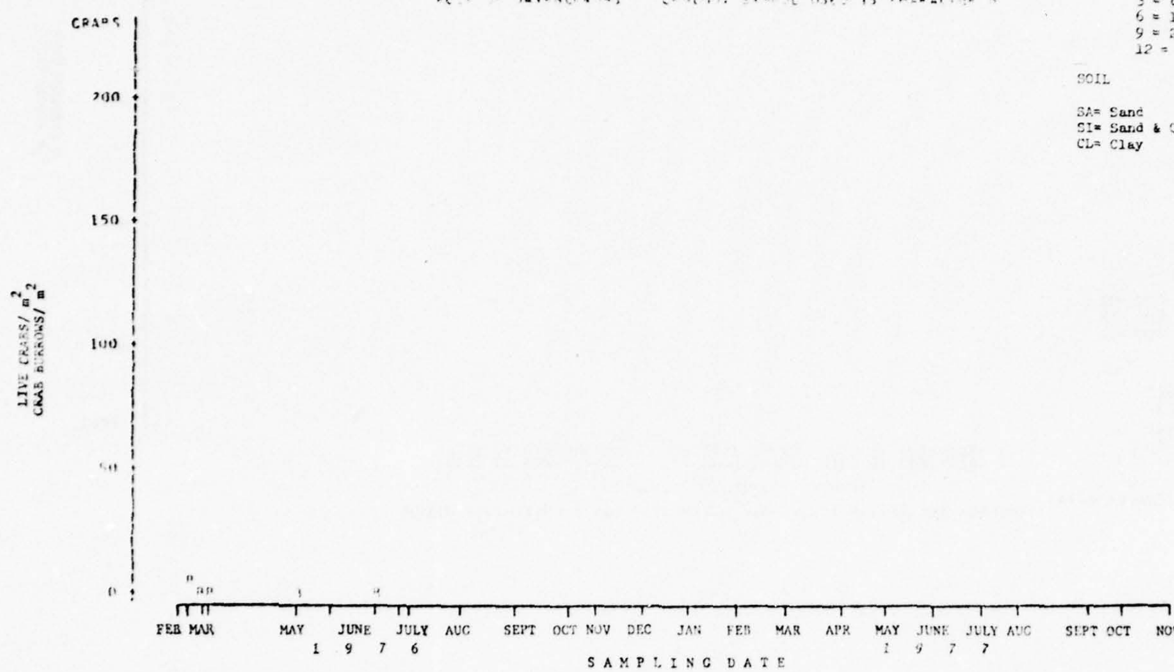
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:33 WEDNESDAY, DECEMBER 21, 1977 93

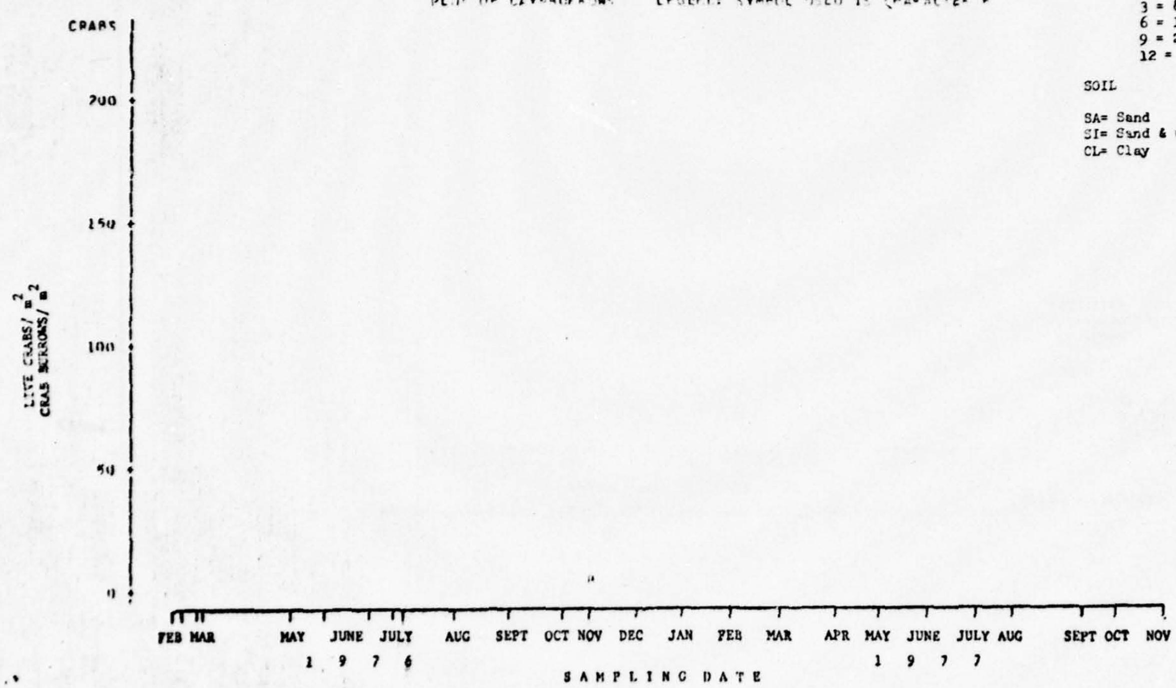
HEIGHT=24 SOIL=CL MON=J

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

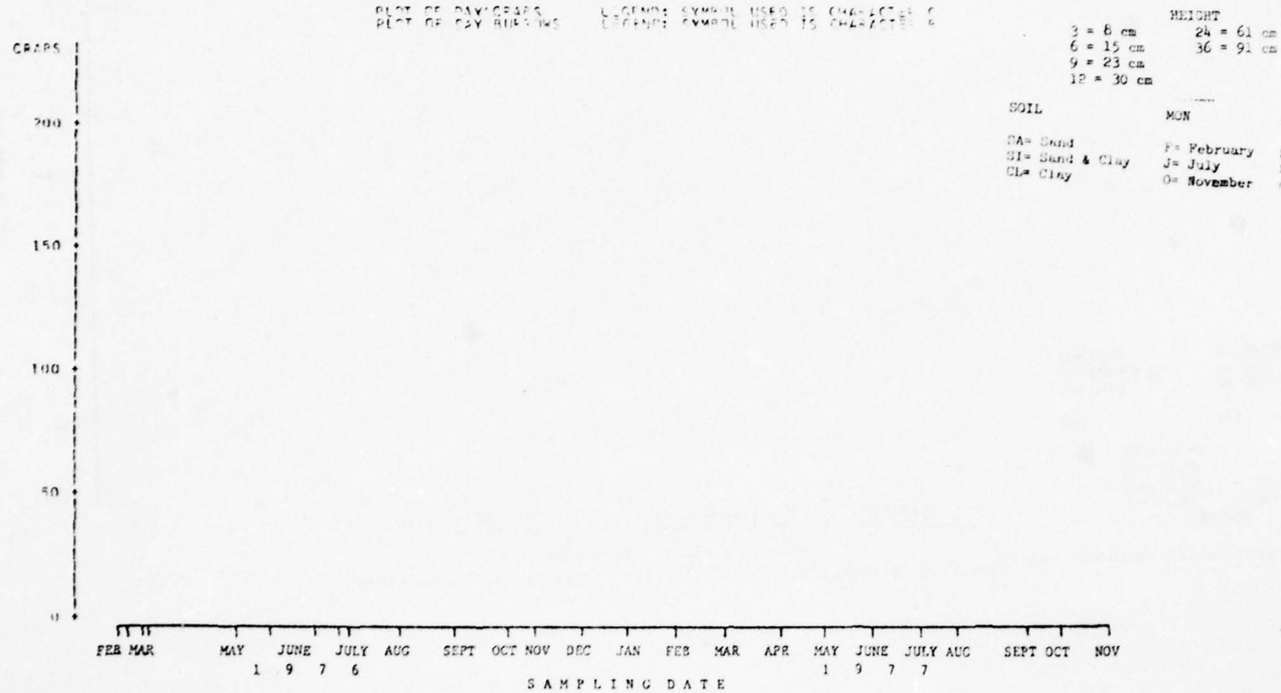
MON
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 94

HEIGHT=24 SOIL=CL MON=O

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER 6



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 95

HEIGHT=24 SOIL=SA MON=F

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT

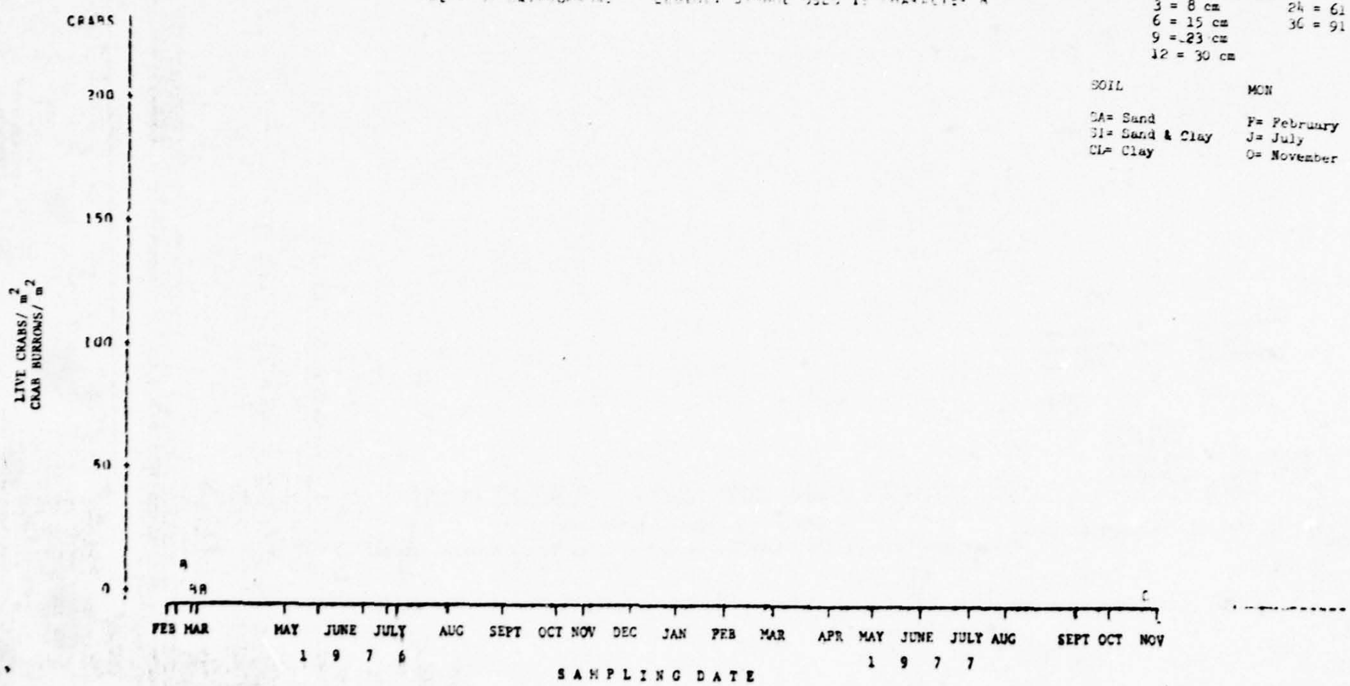
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
30 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

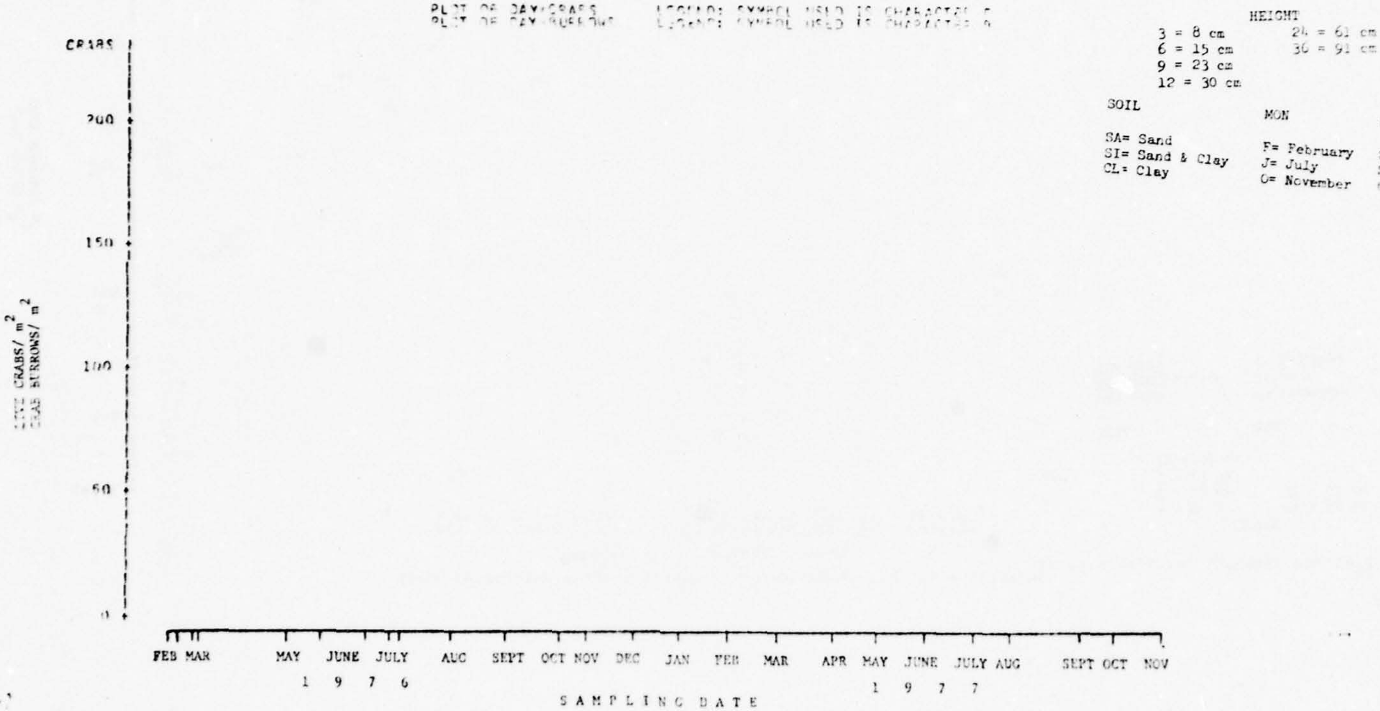
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING
16:33 WEDNESDAY, DECEMBER 21, 1977 96

HEIGHT=24 SOIL=SA MON=J

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 97
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=24 SOIL=SA MON=O

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT

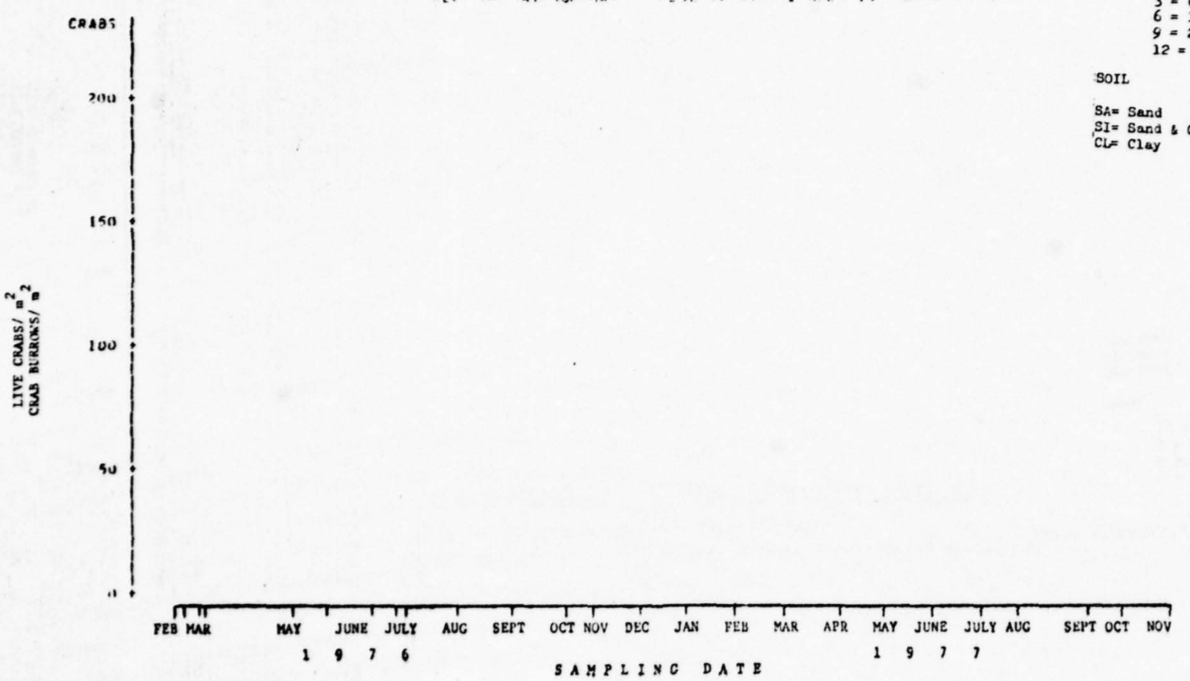
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

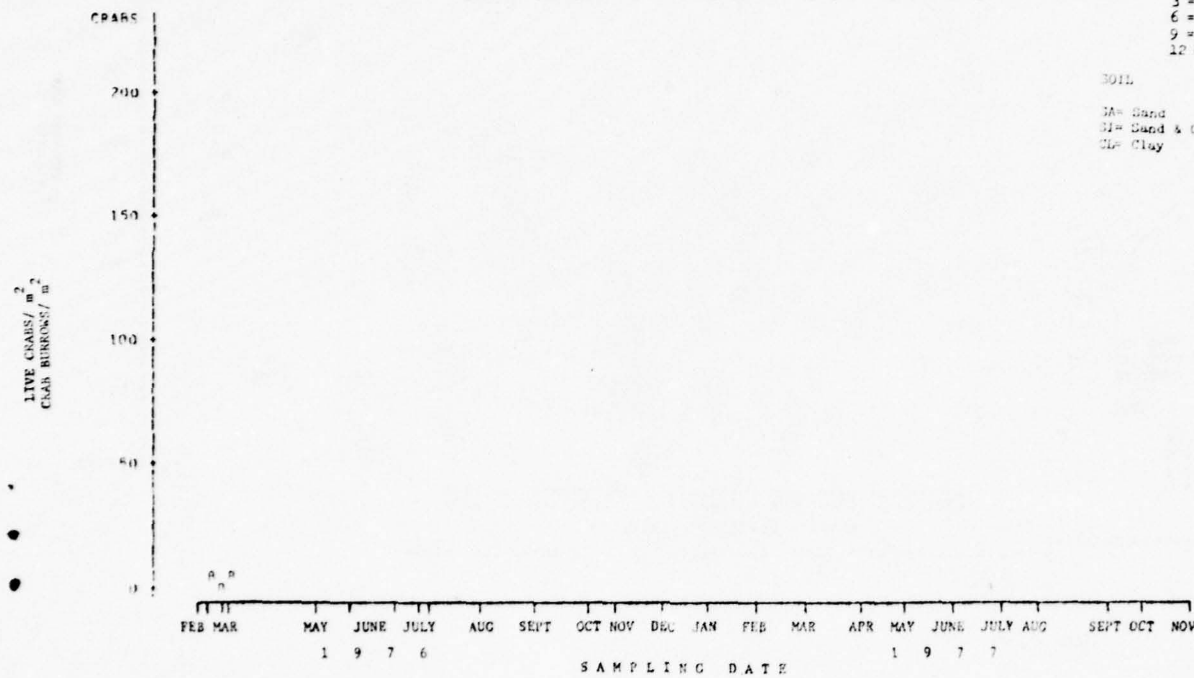
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 98
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=24 SOIL=SI MON=F

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

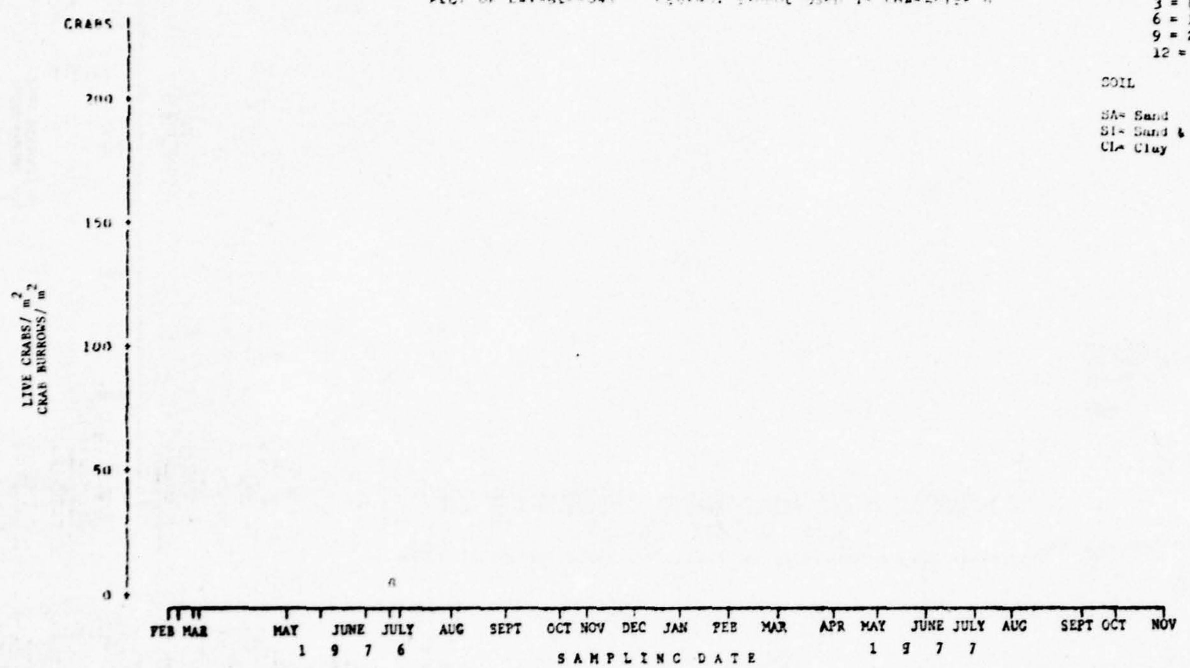
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

MON
F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 99

HEIGHT=24 SOIL=SI MON=J

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

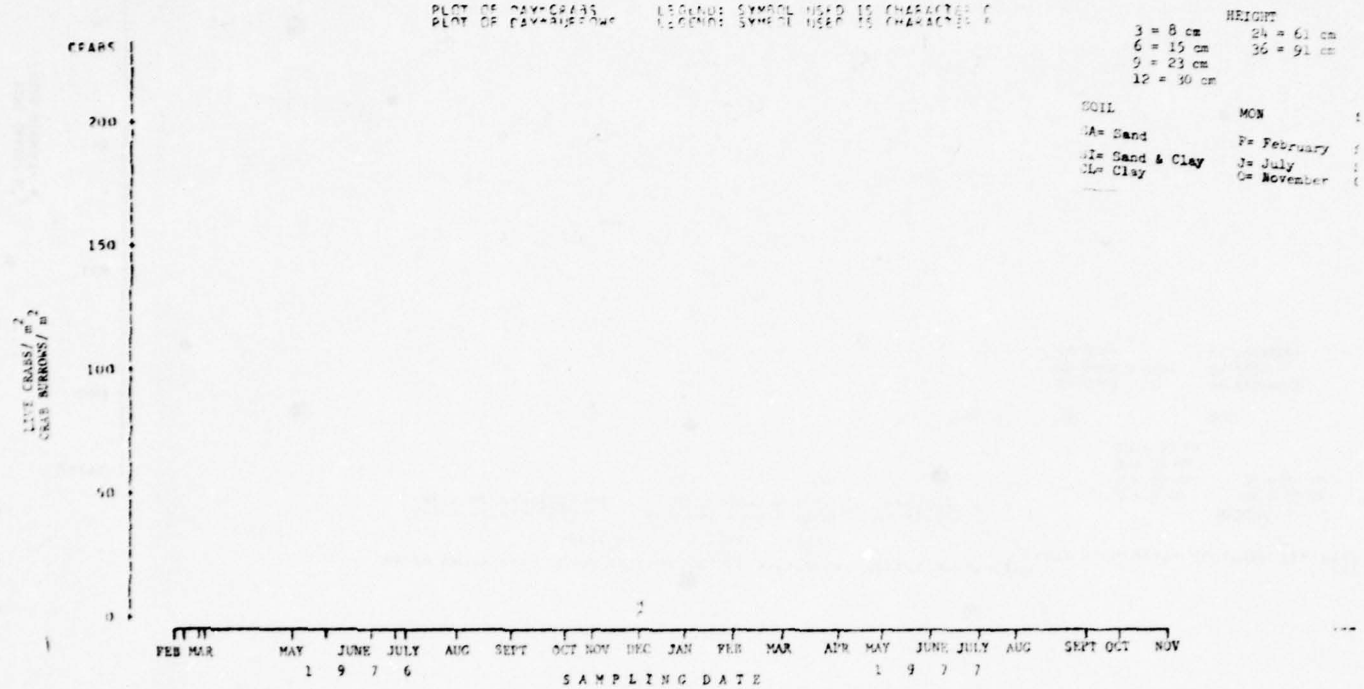
MON

F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 15:23 WEDNESDAY, DECEMBER 21, 1977 100

HEIGHT=24 SOIL=SI MON=O

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 101

HEIGHT=36 SOIL=CL MON=F

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT

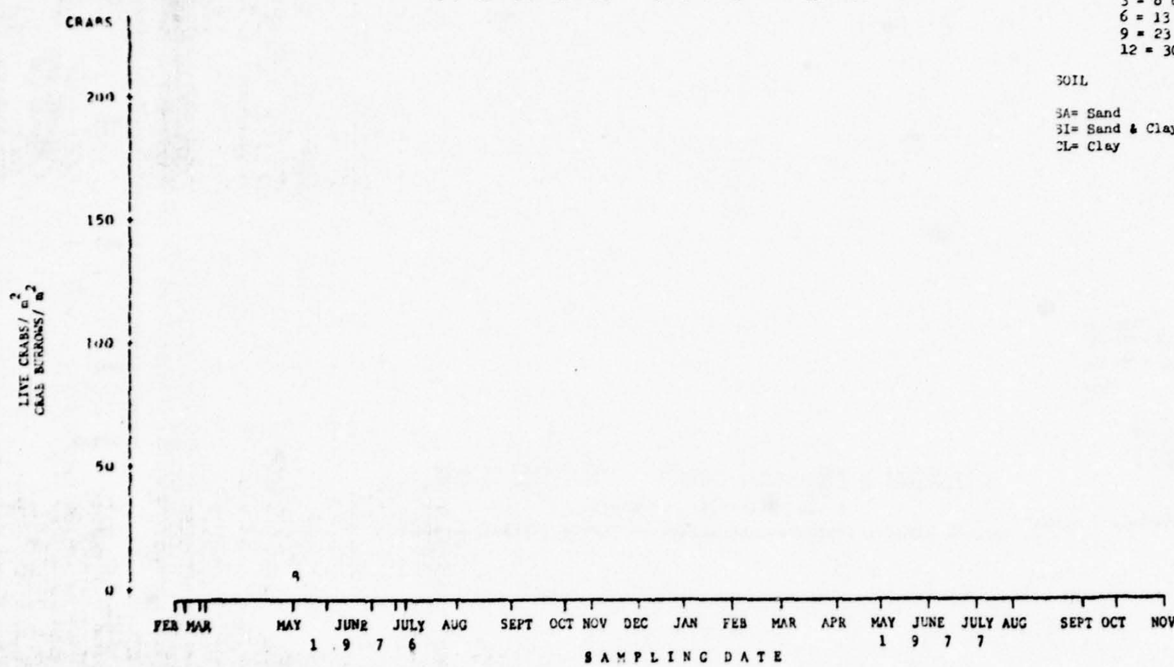
3 = 8 cm
6 = 13 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

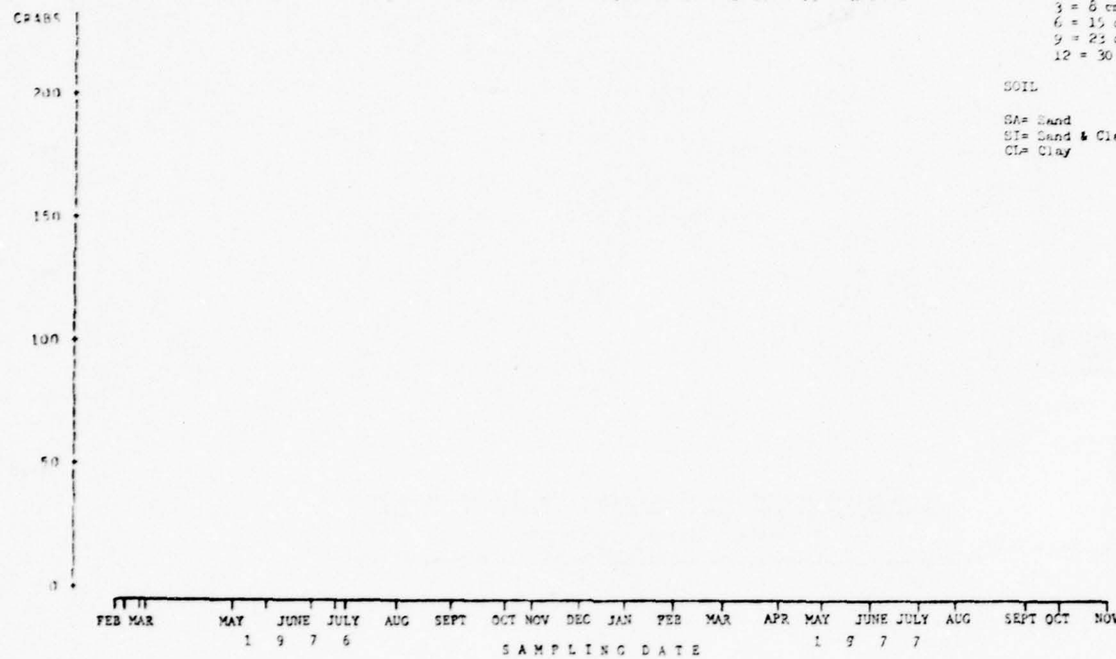
F= February
J= July
O= November



MARSH ENGINEERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=36 SOIL=CL MON=J

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

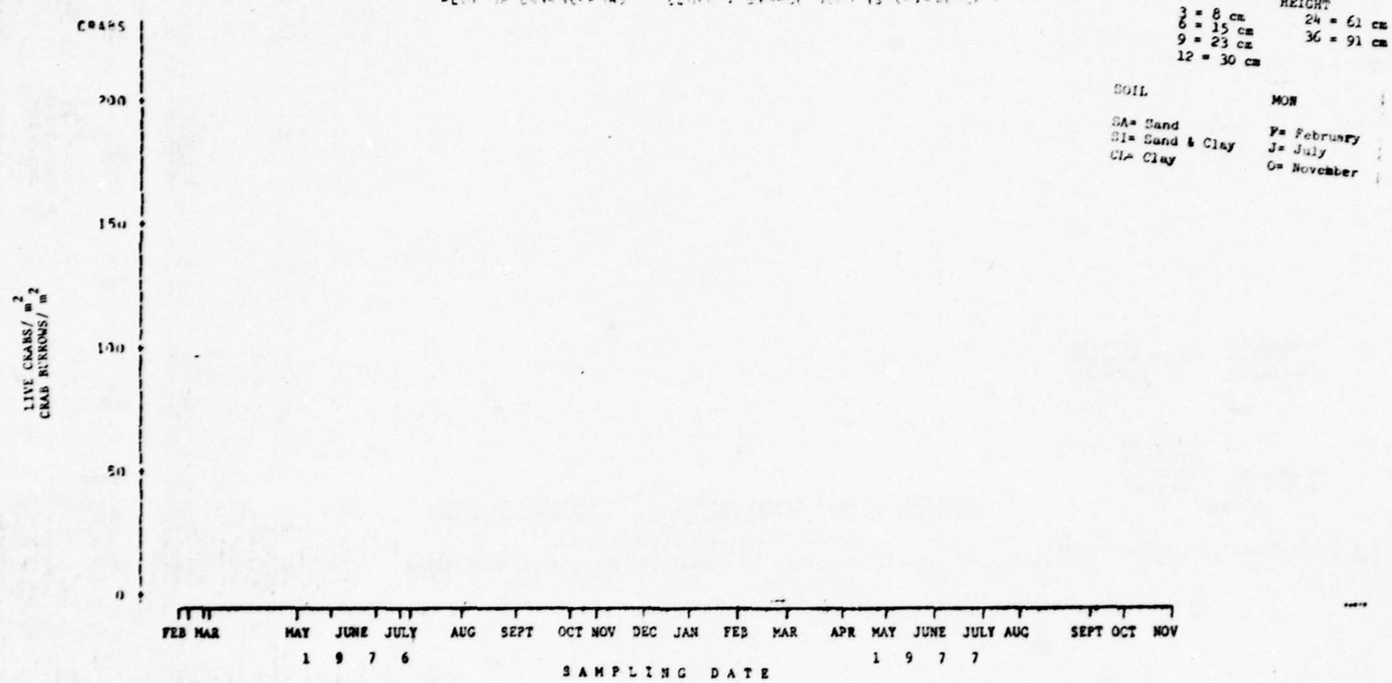
SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November

B133

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 103
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=36 SOIL=CL MON=O

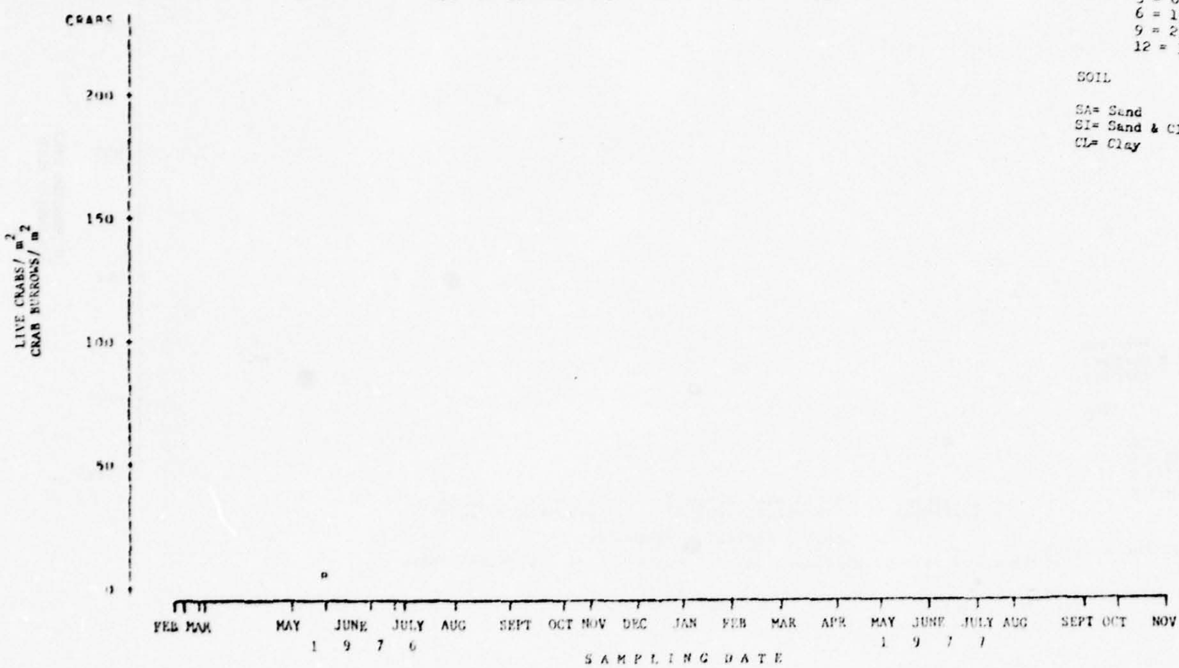
PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 104
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=36 SOIL=SA MON=F

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

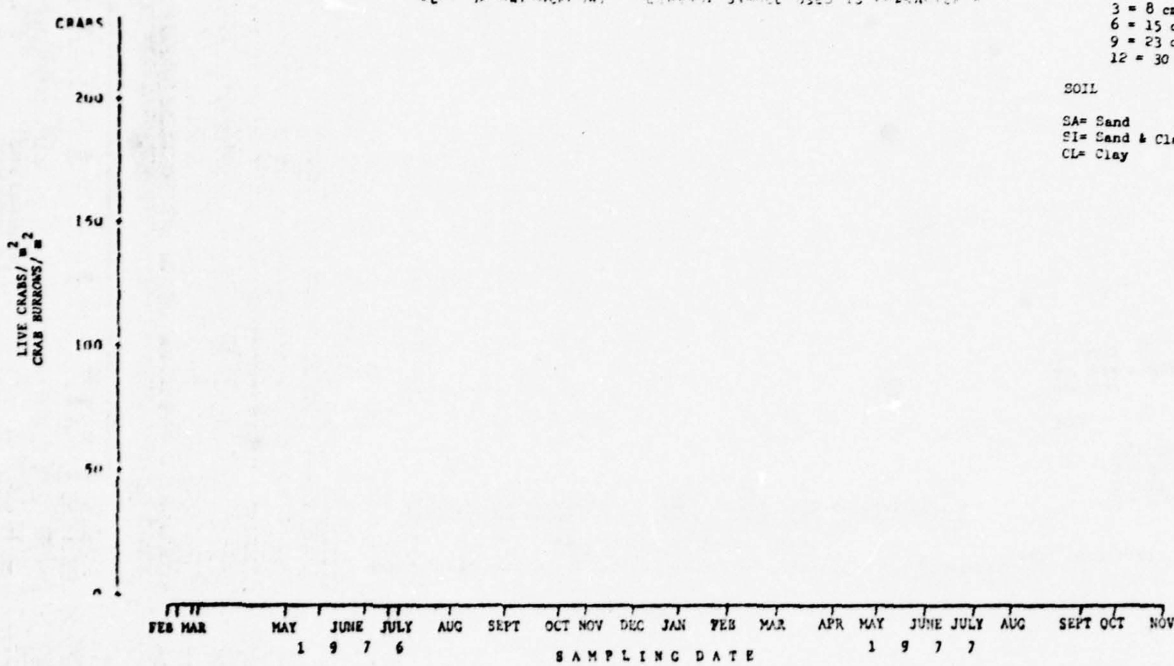
F= February
J= July
C= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 105

16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=36 SOIL=SA MON=O

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

MON
F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 106

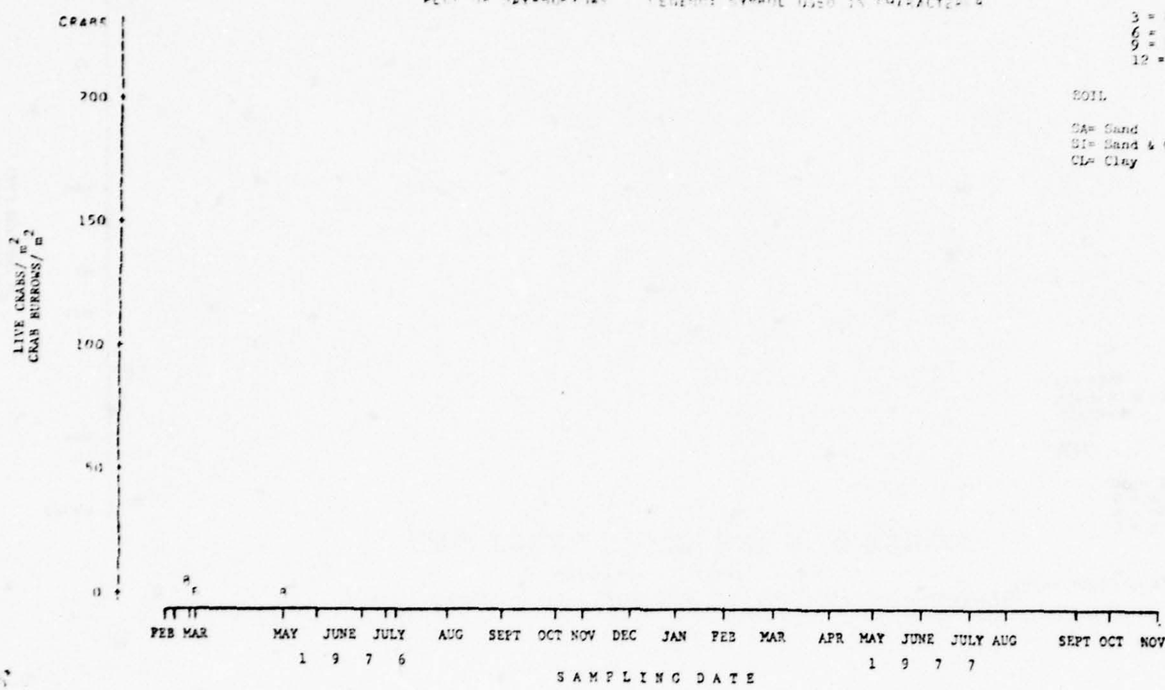
HEIGHT=36 SOIL=SI MON=F

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER

HEIGHT
3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 30 cm

SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

MON
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 107

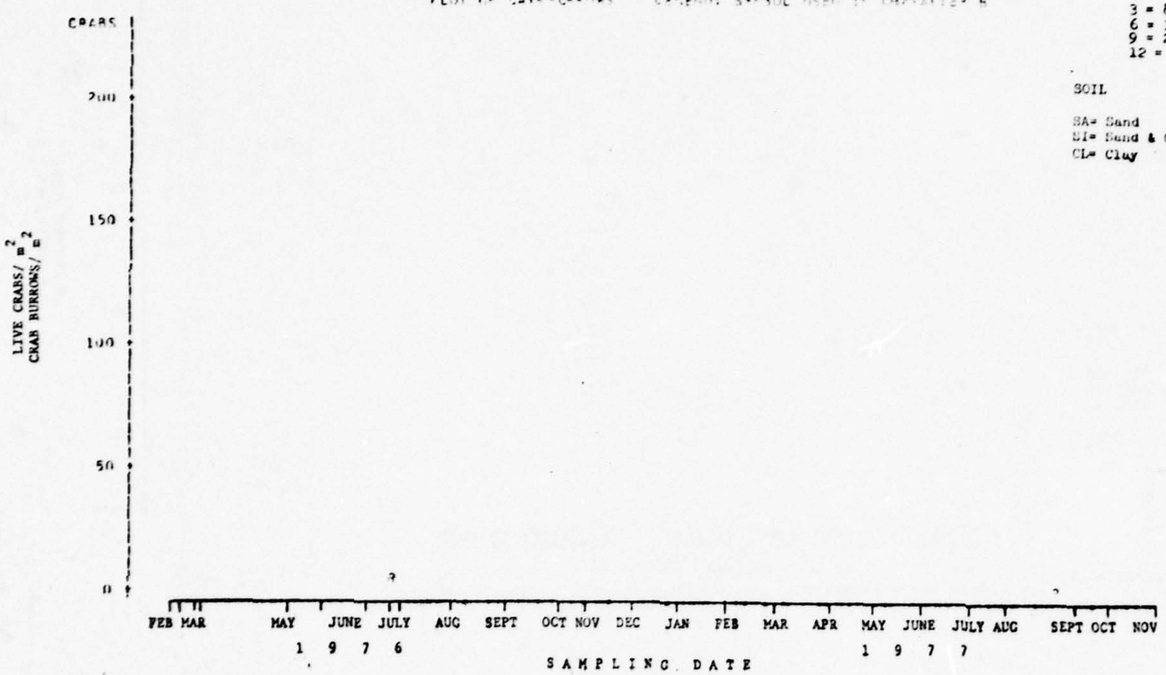
HEIGHT=36 SOIL=SI MON=J

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B

HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

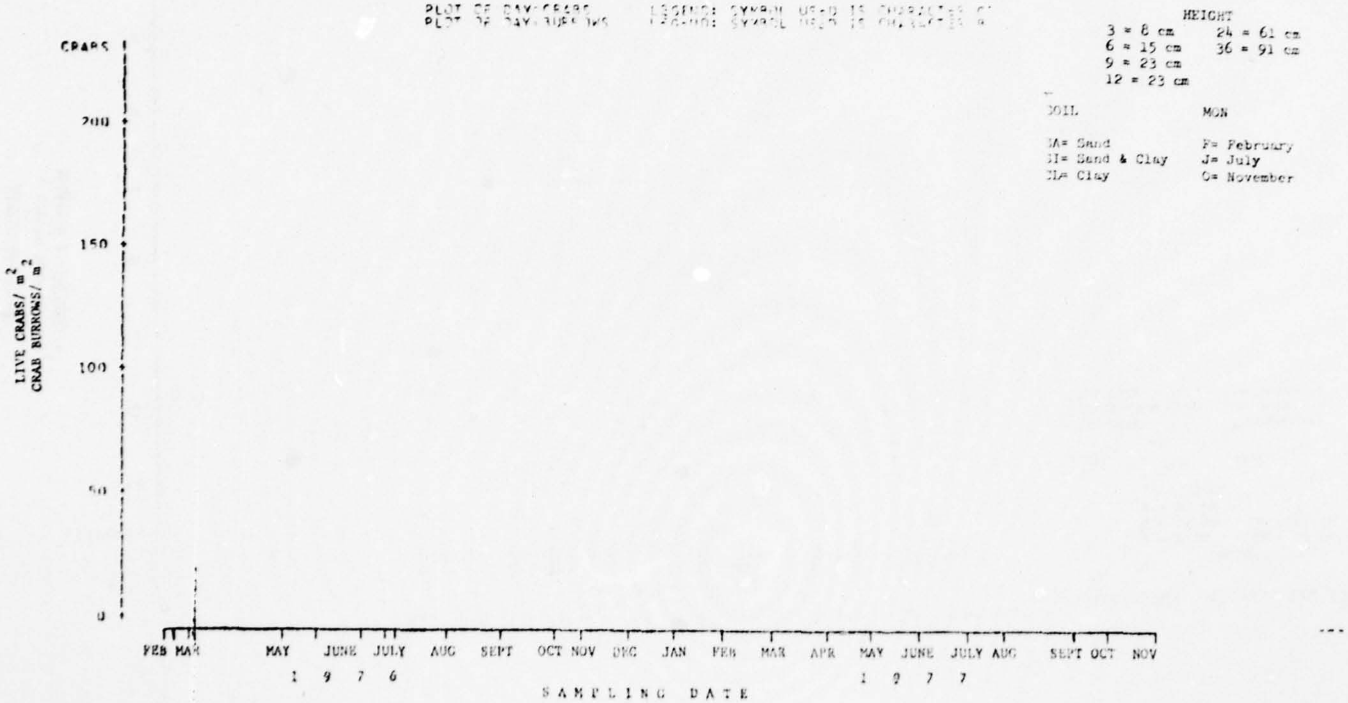
SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 108
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=36 SOIL=SI MON=O

PLOT OF DAY*CRABS LEGEND: SYMBOL USED IS CHARACTER C
PLOT OF DAY*BURROWS LEGEND: SYMBOL USED IS CHARACTER B



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 109
16:23 WEDNESDAY, DECEMBER 21, 1977

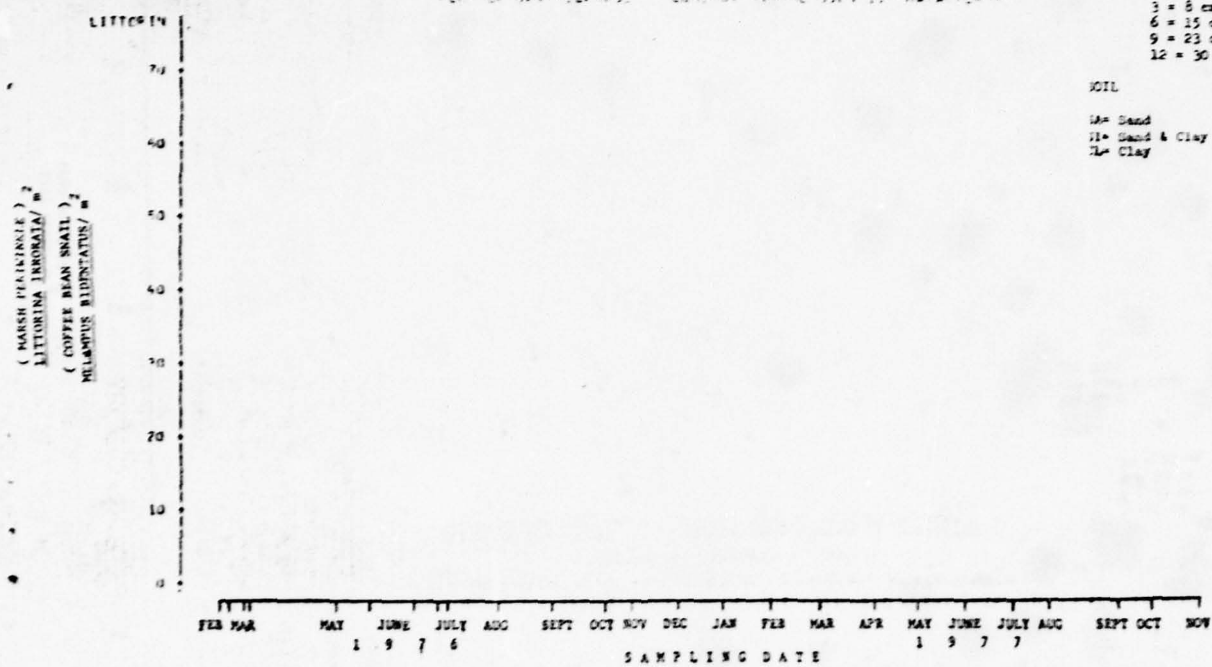
HEIGHT=, SOIL= MON=

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER

HEIGHT

3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 30 cm

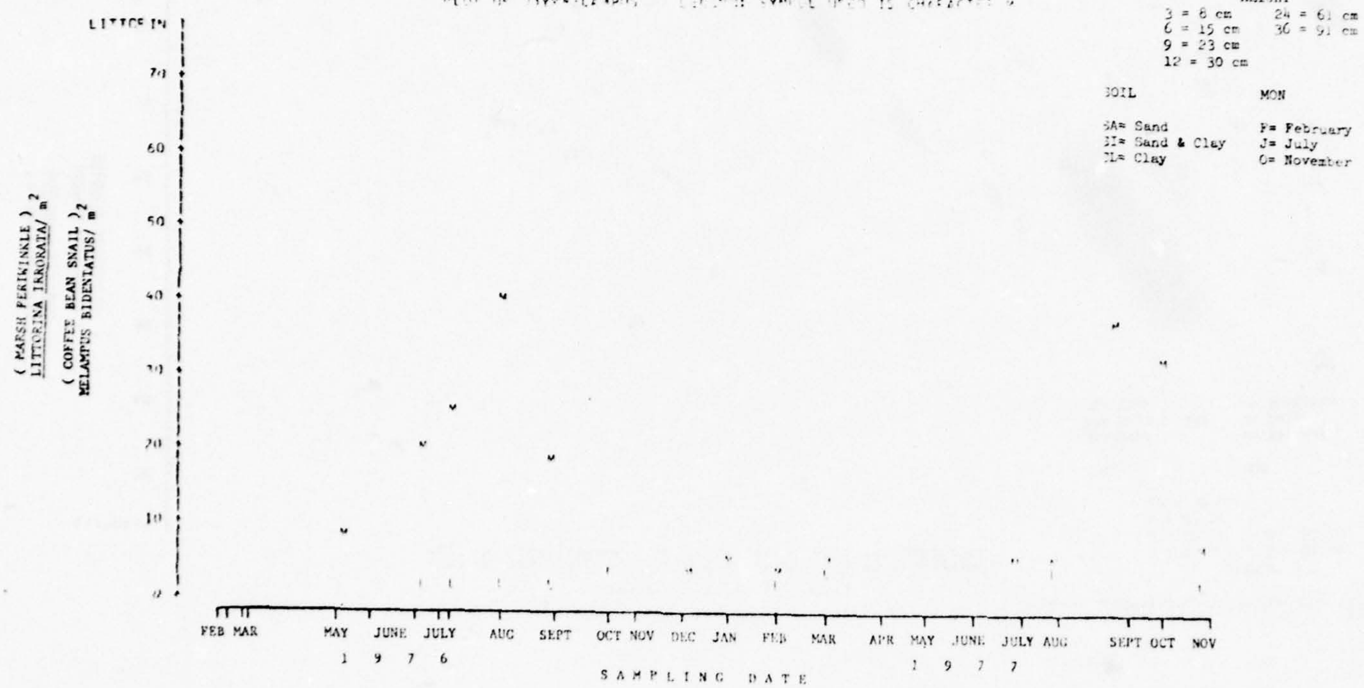
SOIL	MON
1A= Sand	F= February
2I= Sand & Clay	J= July
3L= Clay	O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 110

HEIGHT=3 SOIL=CL MON=F

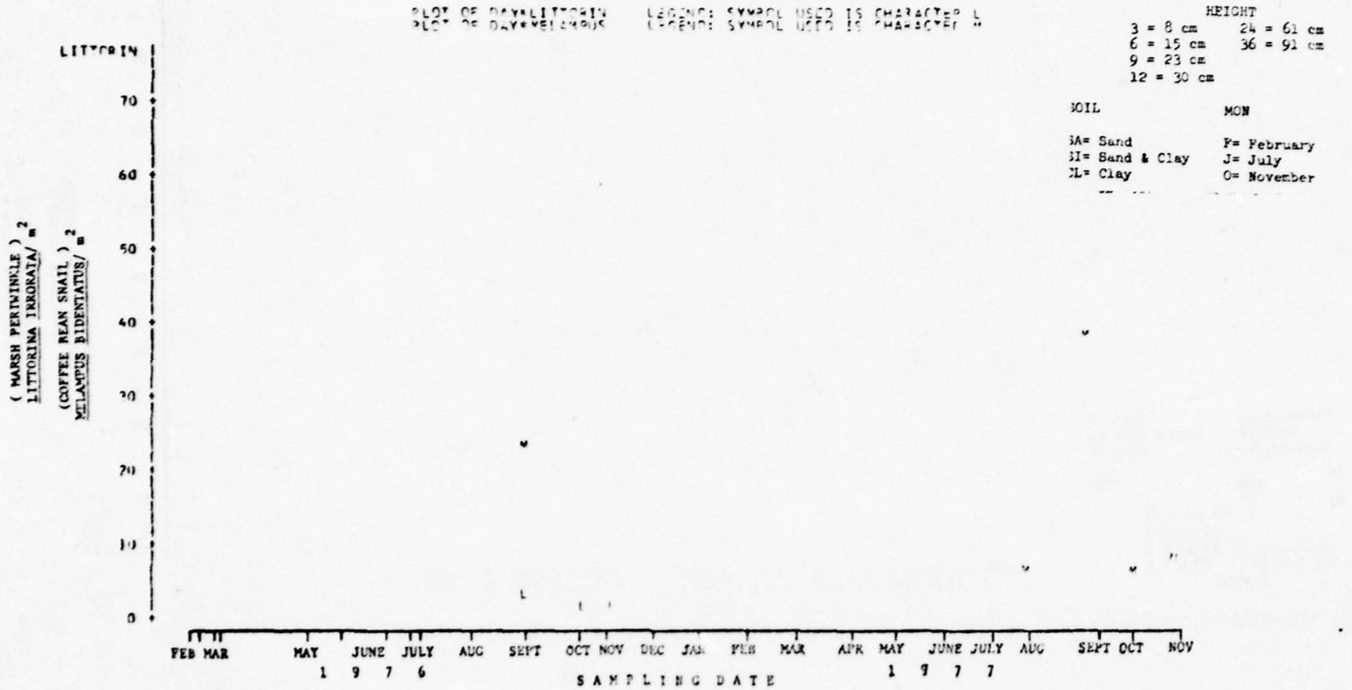
PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 111

HEIGHT=3 SOIL=CL MON=J

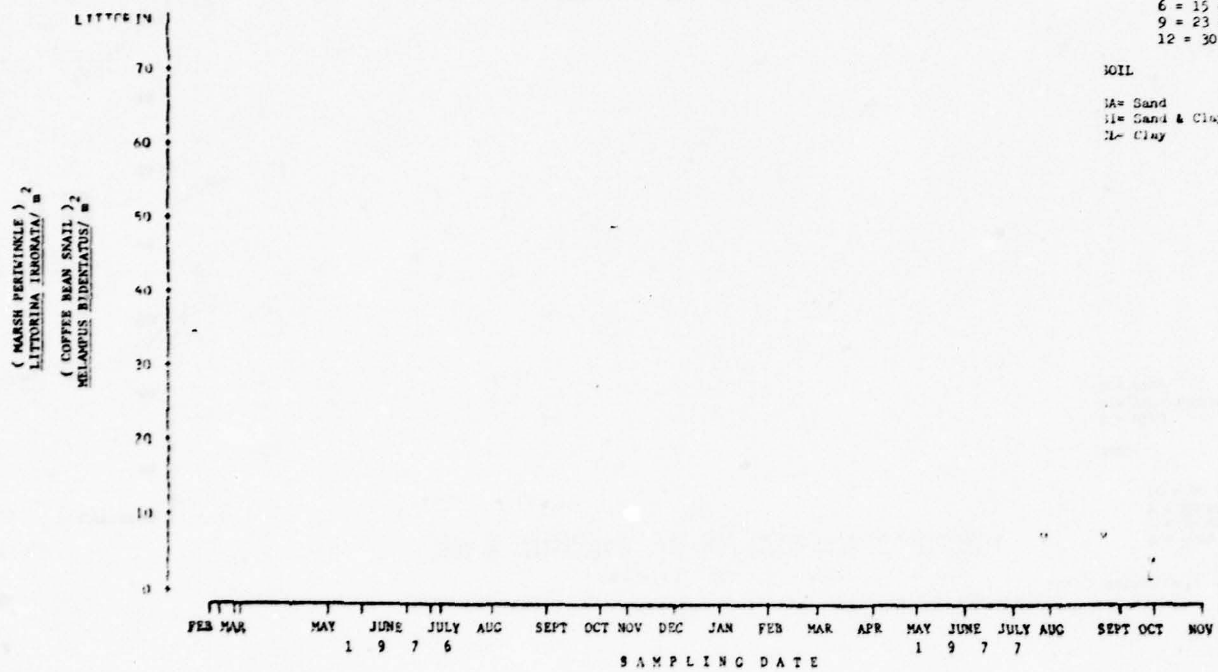
PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 112
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=[illegible] SOIL=CL MON=O

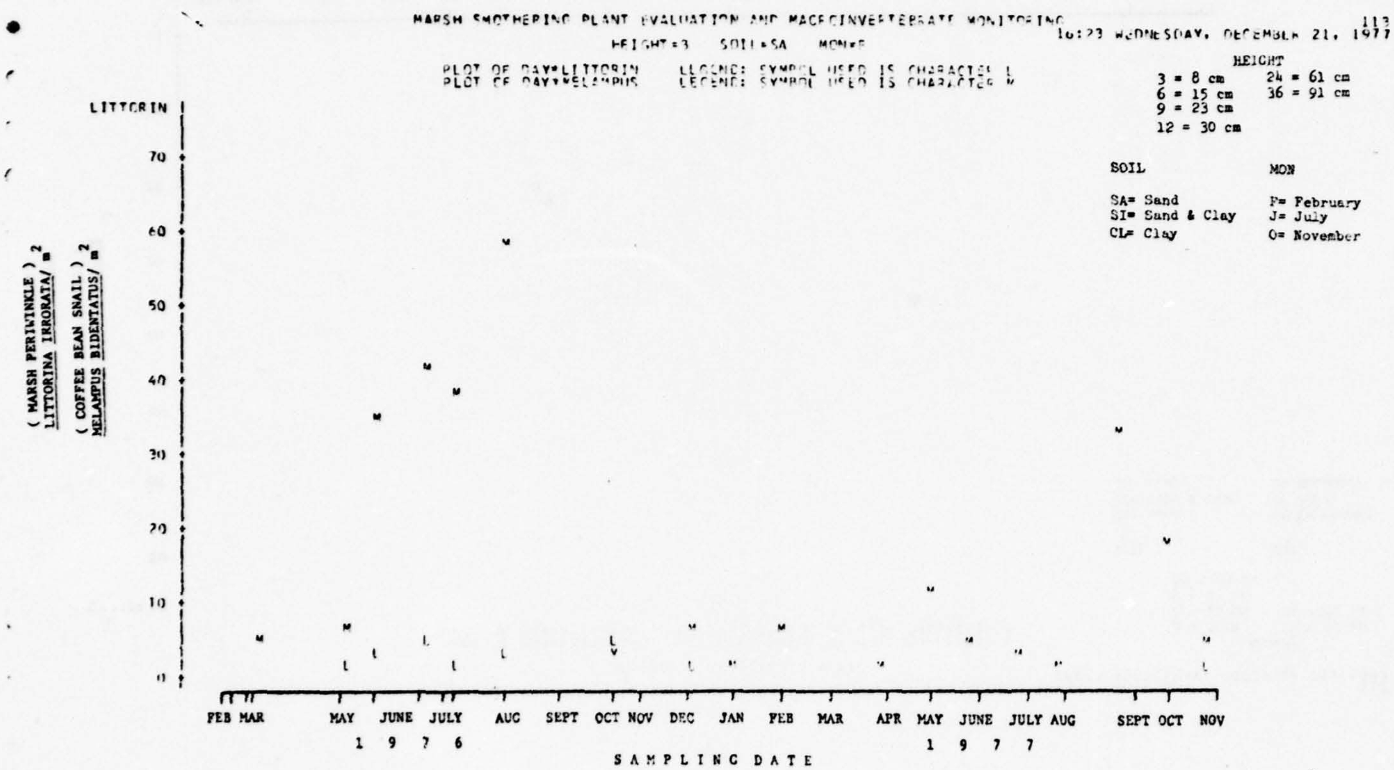
PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT
3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 30 cm

SOIL
SA= Sand
SL= Sand & Clay
CL= Clay

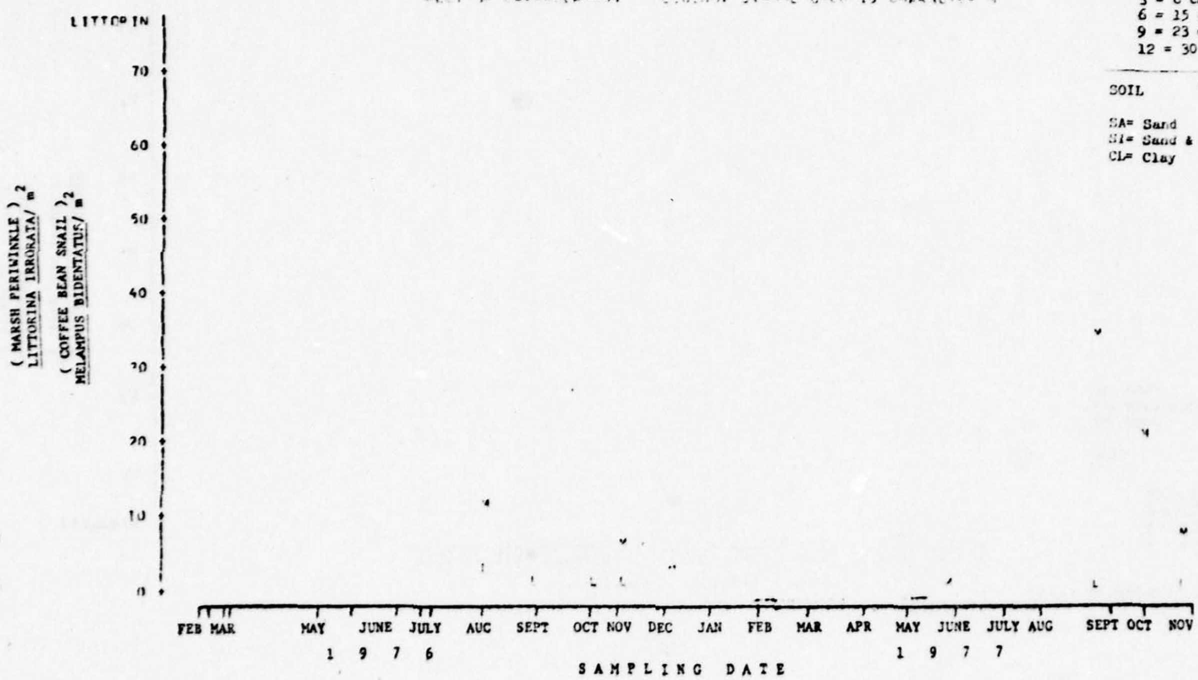
MON
F= February
J= July
O= November


MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING
113
16:23 WEDNESDAY, DECEMBER 21, 1977
HEIGHT=3 SOIL=SA MON=F
PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M
HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay
MON
F= February
J= July
O= November
LITTORIN
(MARSH PERIWINKLE) LITTORINA IRRORATA/ m2
(COFFEE BEAN SNAIL) MELAMPUS BIDENTATUS/ m2
70
60
50
40
30
20
10
0
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 114

HEIGHT=3 SOIL=SA MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

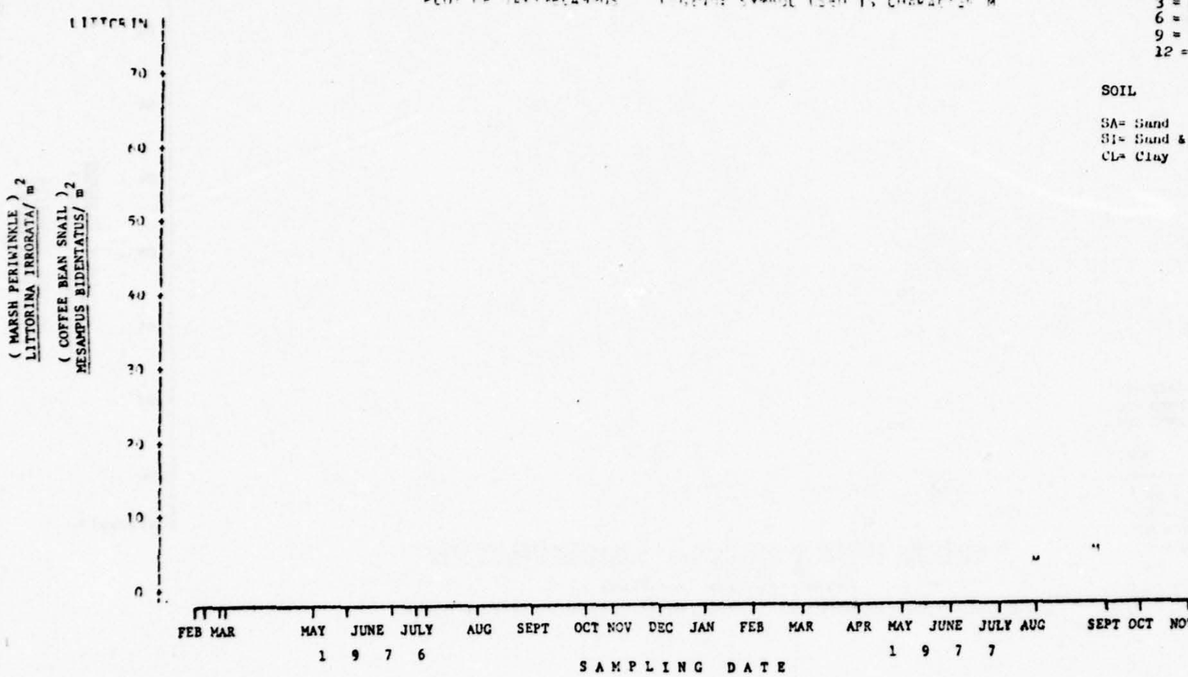
MON

F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 115
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=3 SOIL=SA MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT

3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 30 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

B146

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 116

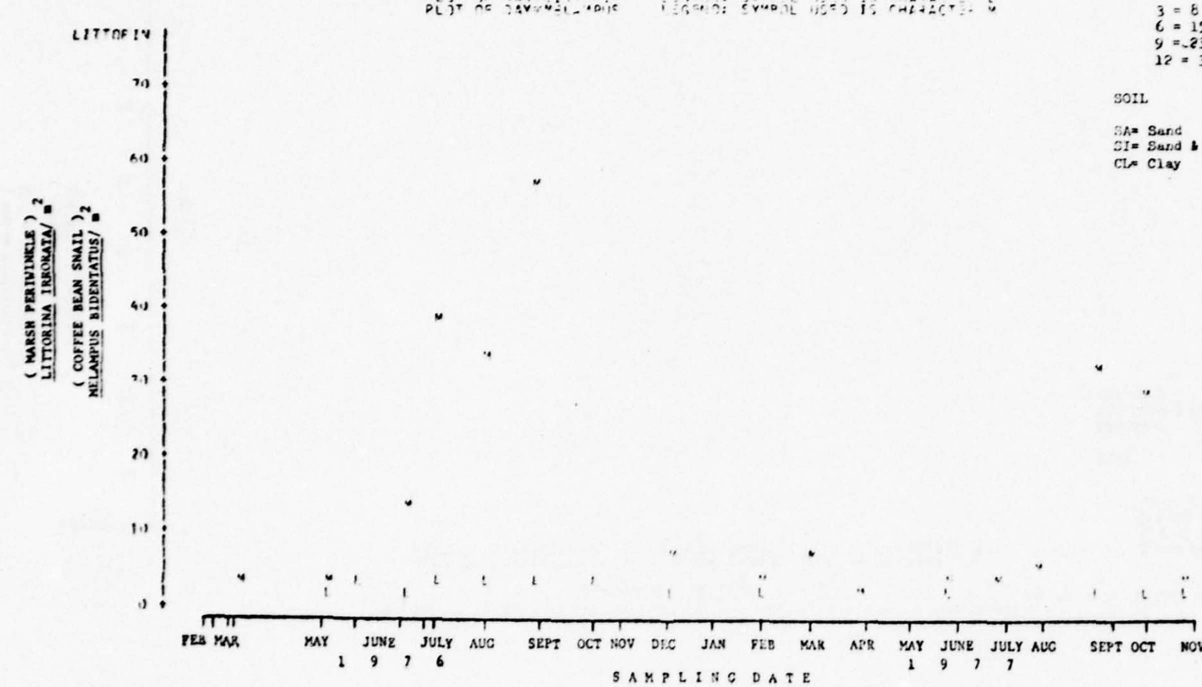
HEIGHT=3 SOIL=SI MON=F

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 30 cm

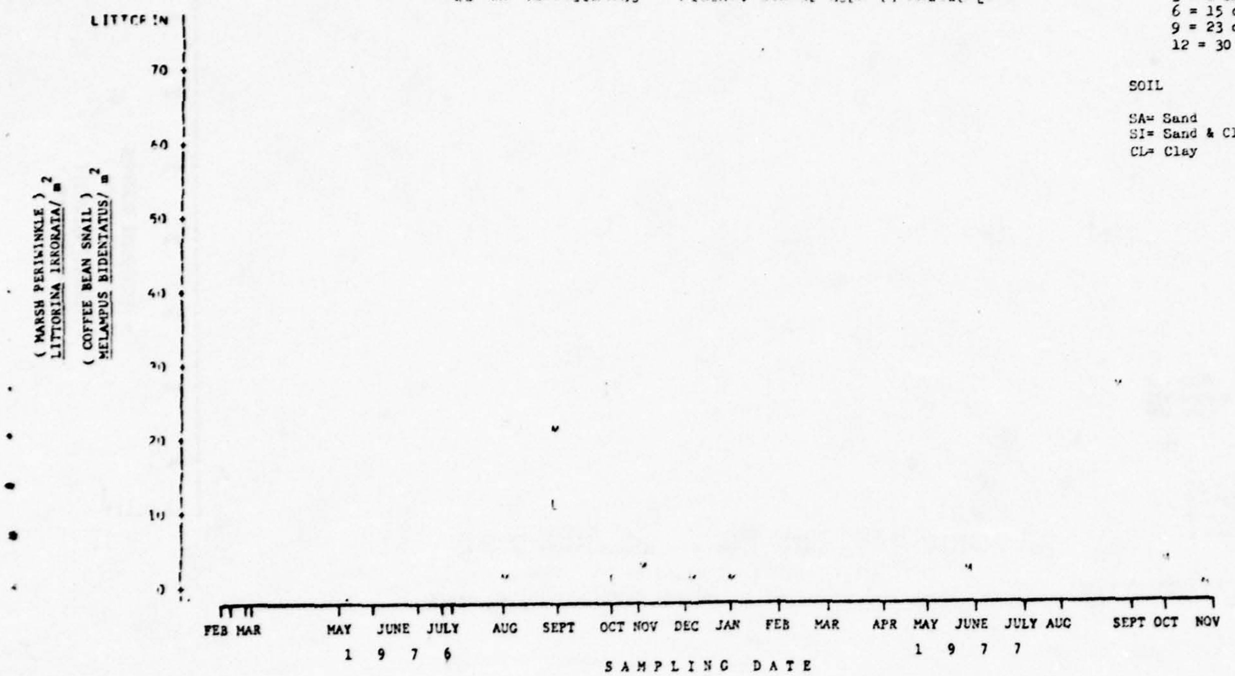
SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 117
15:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=3 SOIL=SI MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

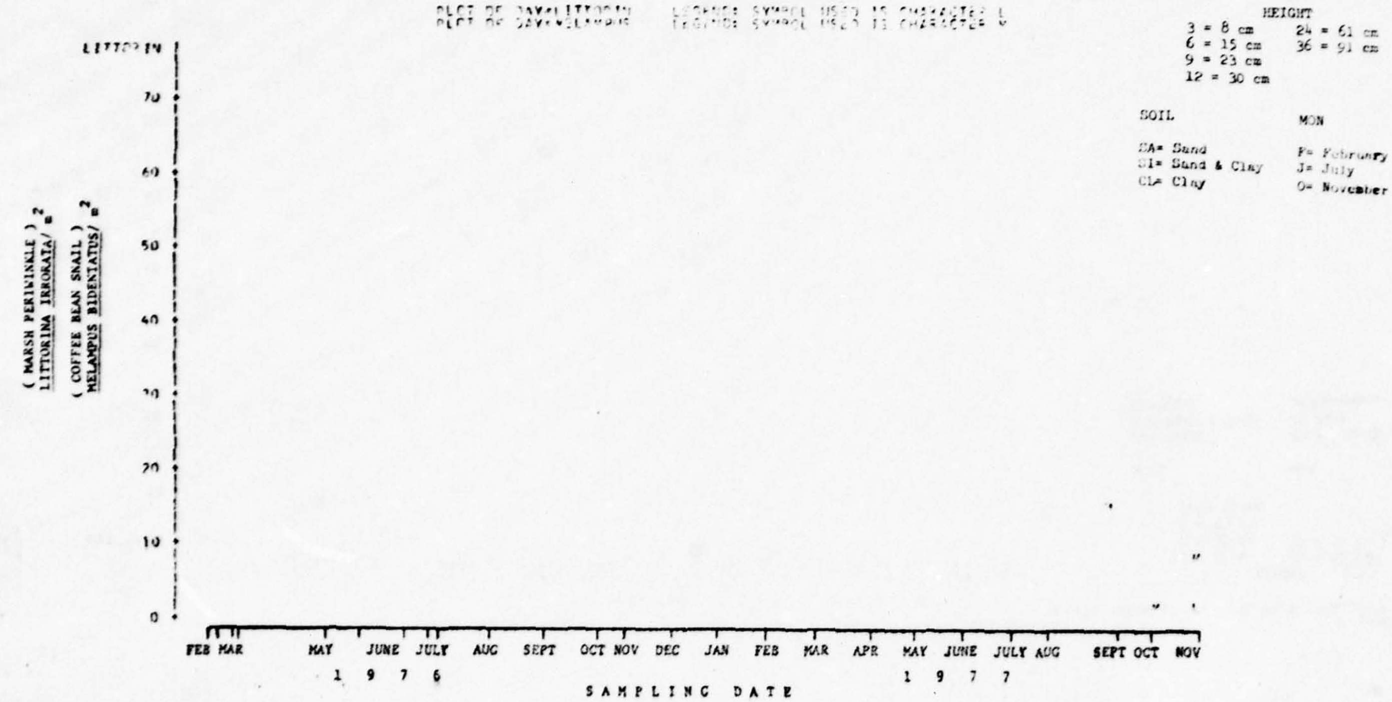
MON

F= February
J= July
O= November

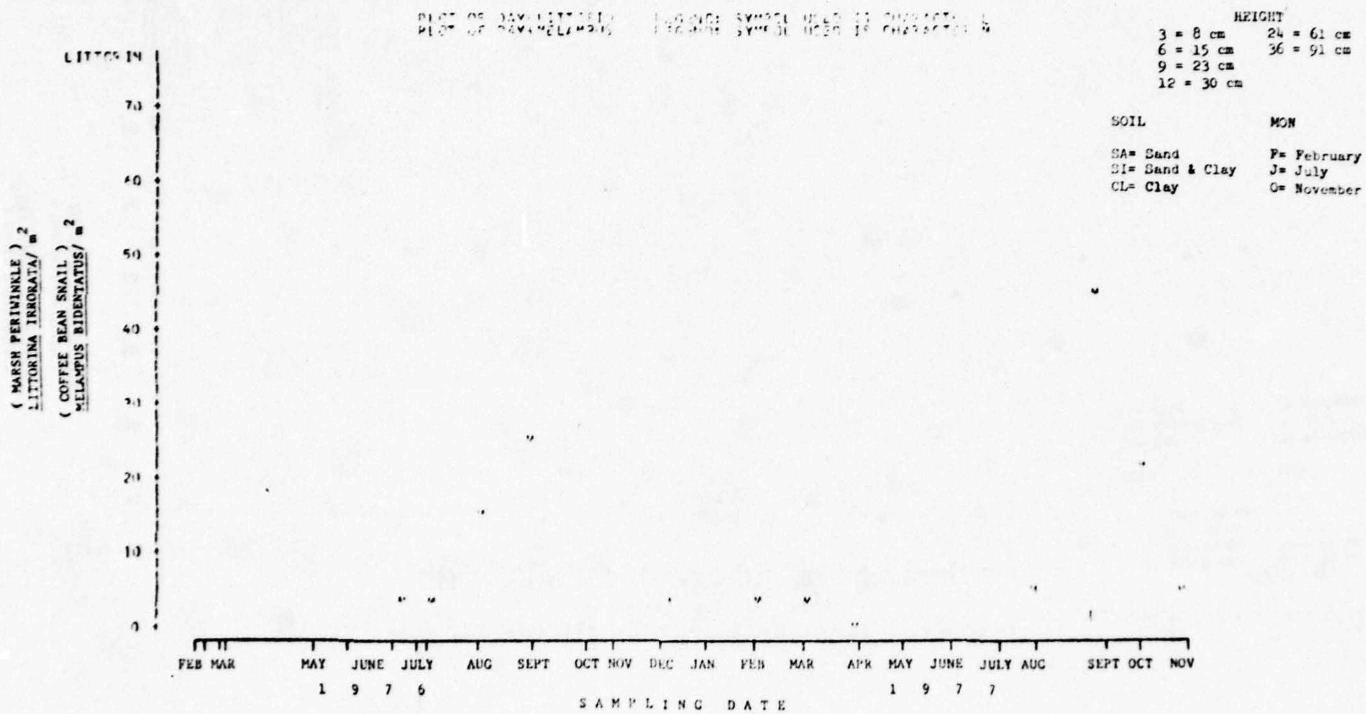
MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 118

HEIGHT=? SOIL=SI MON=O

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



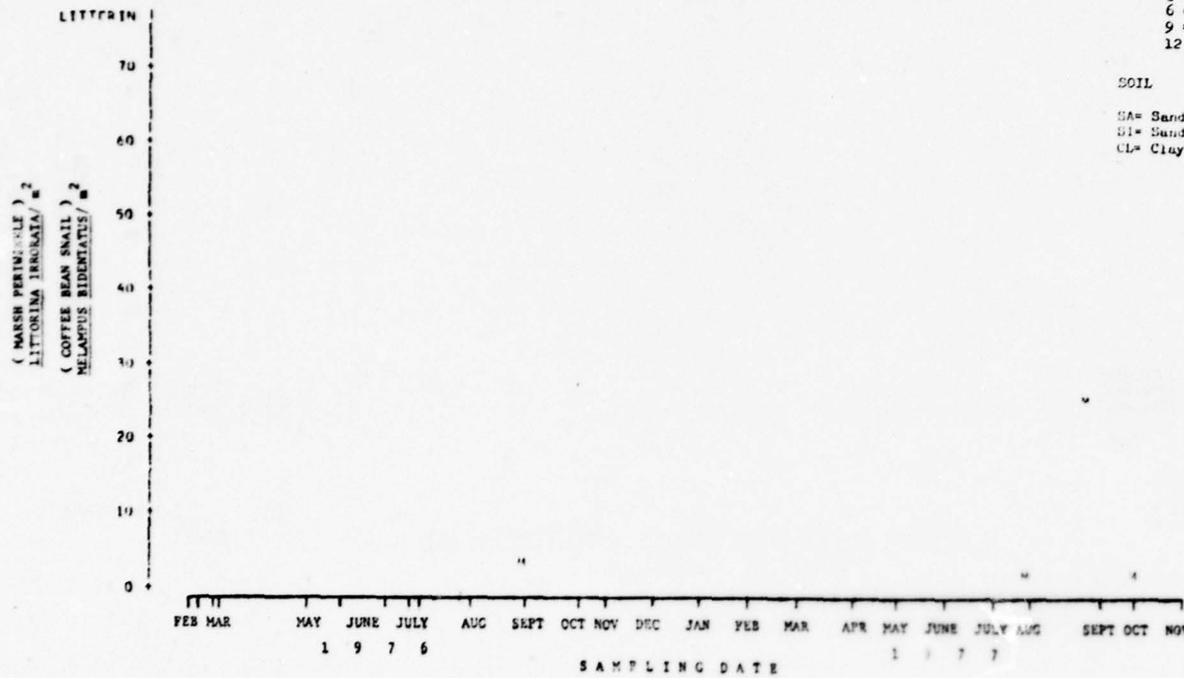
MARSH SMOTHERING PLANT VALUATION AND MACROINVERTEBRATE MONITORING 119
16:23 WEDNESDAY, DECEMBER 21, 1977



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 120

HEIGHT=6 SOIL=CL MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

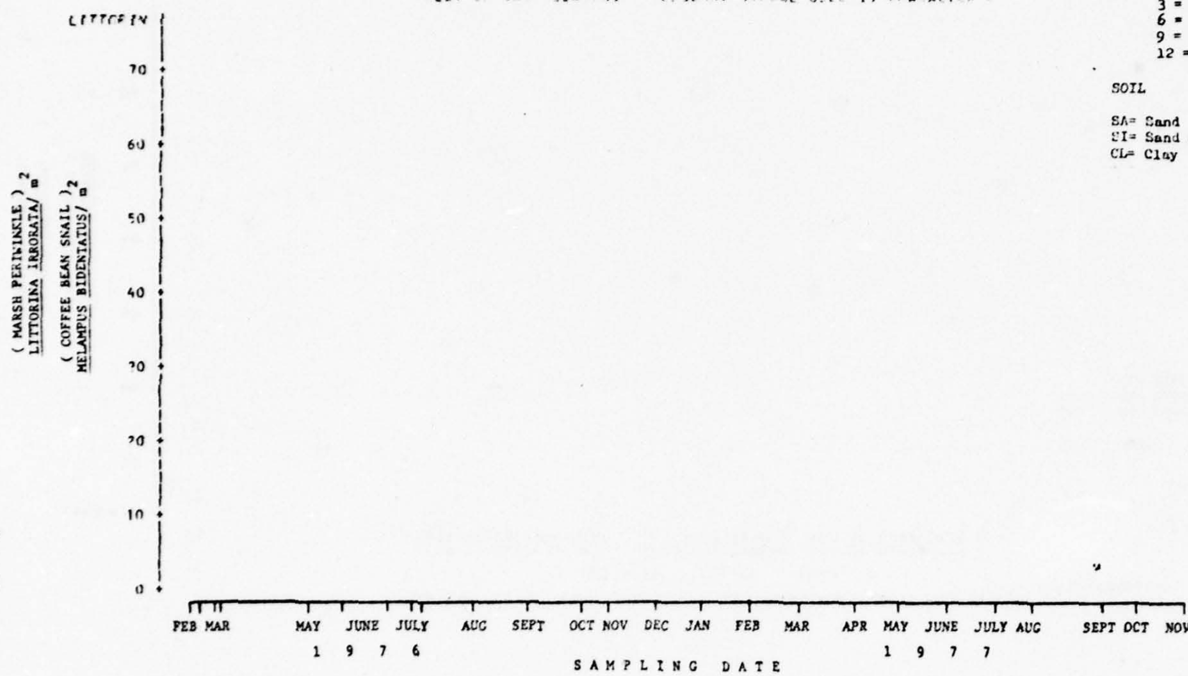
MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 121

16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=6 SOIL=CL MON=O

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L

PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT

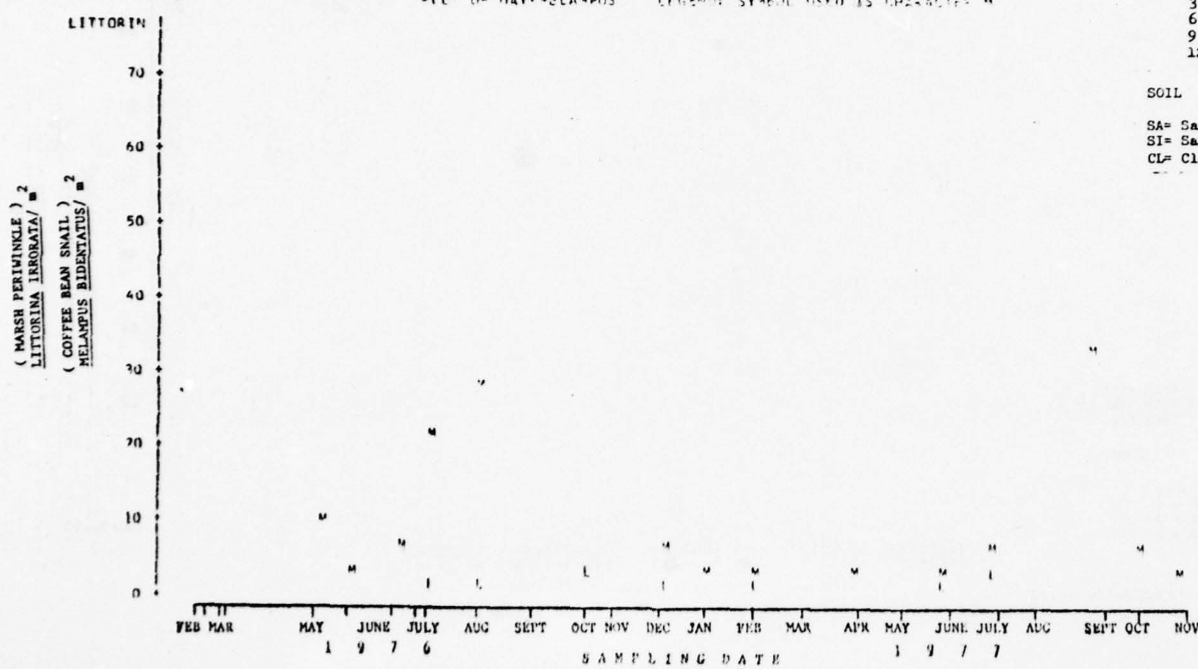
3 = 8 cm	24 = 61 cm
6 = 15 cm	36 = 91 cm
9 = 23 cm	
12 = 30 cm	

SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 122

HEIGHT=6 SOIL=SA MON=F

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



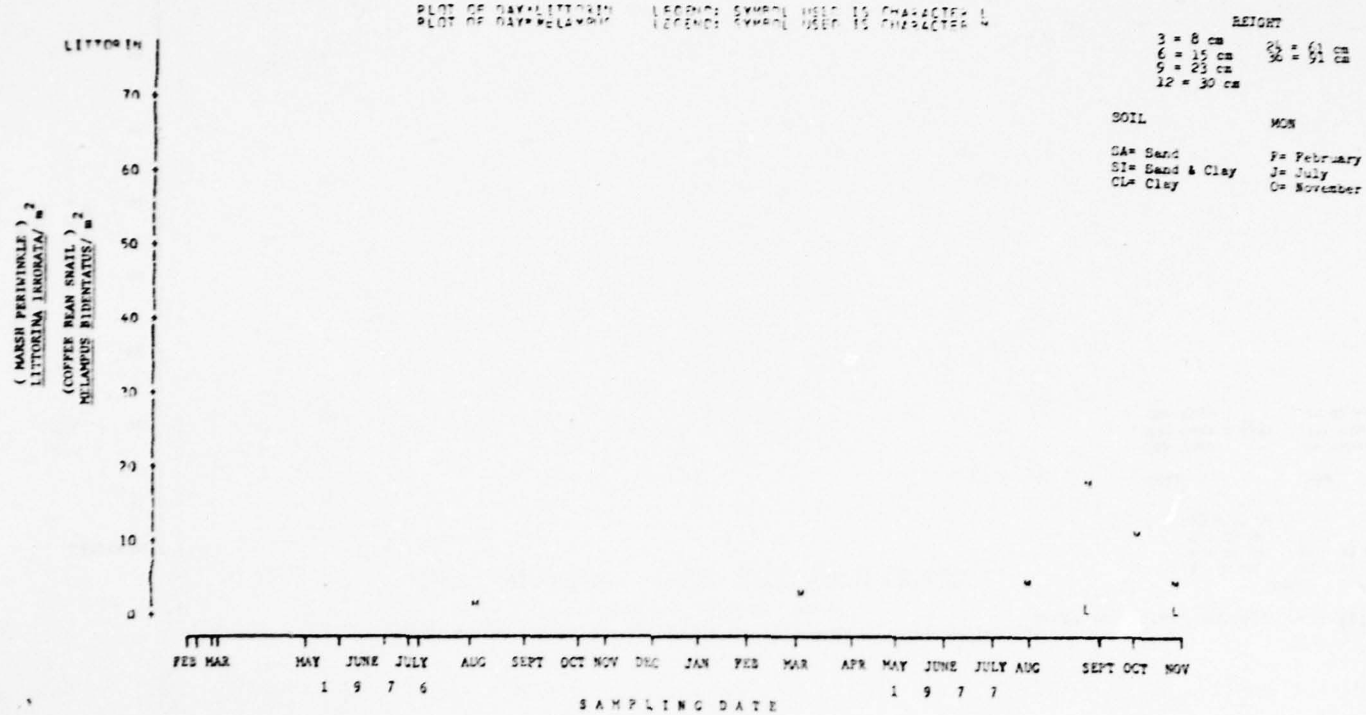
HEIGHT
3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 23 cm

SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 123
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=6 SOIL=SA MON=J

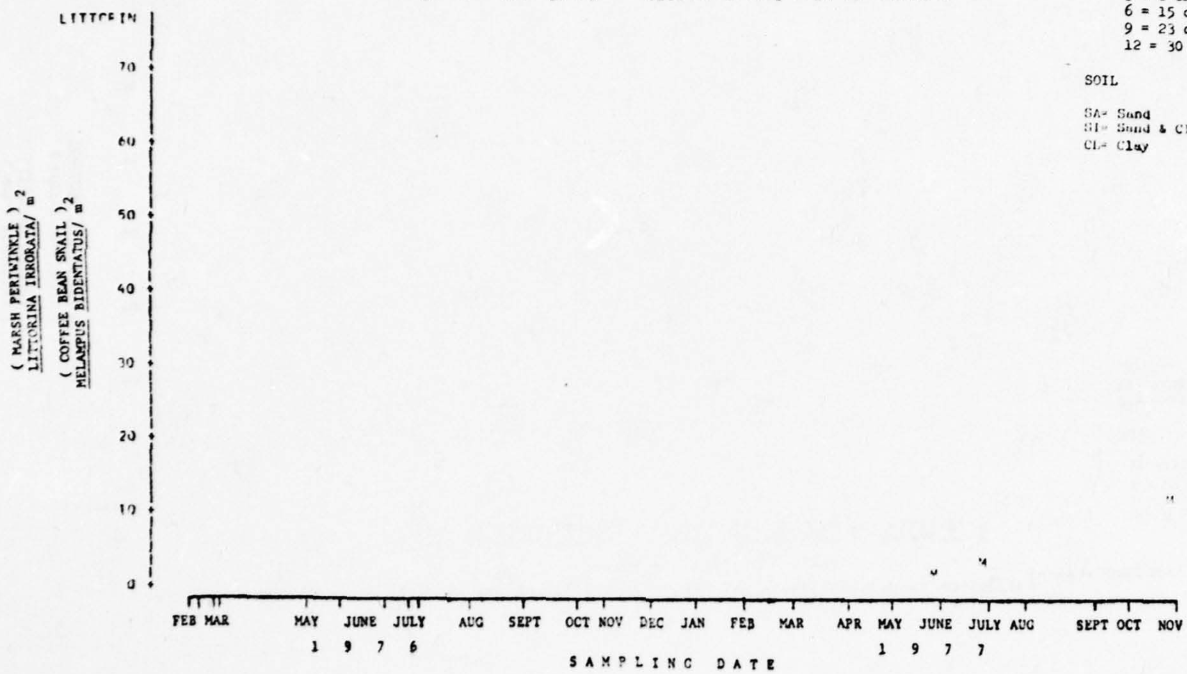
PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:22 WEDNESDAY, DECEMBER 21, 1977 124

HEIGHT=6 SOIL=SA MON=O

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

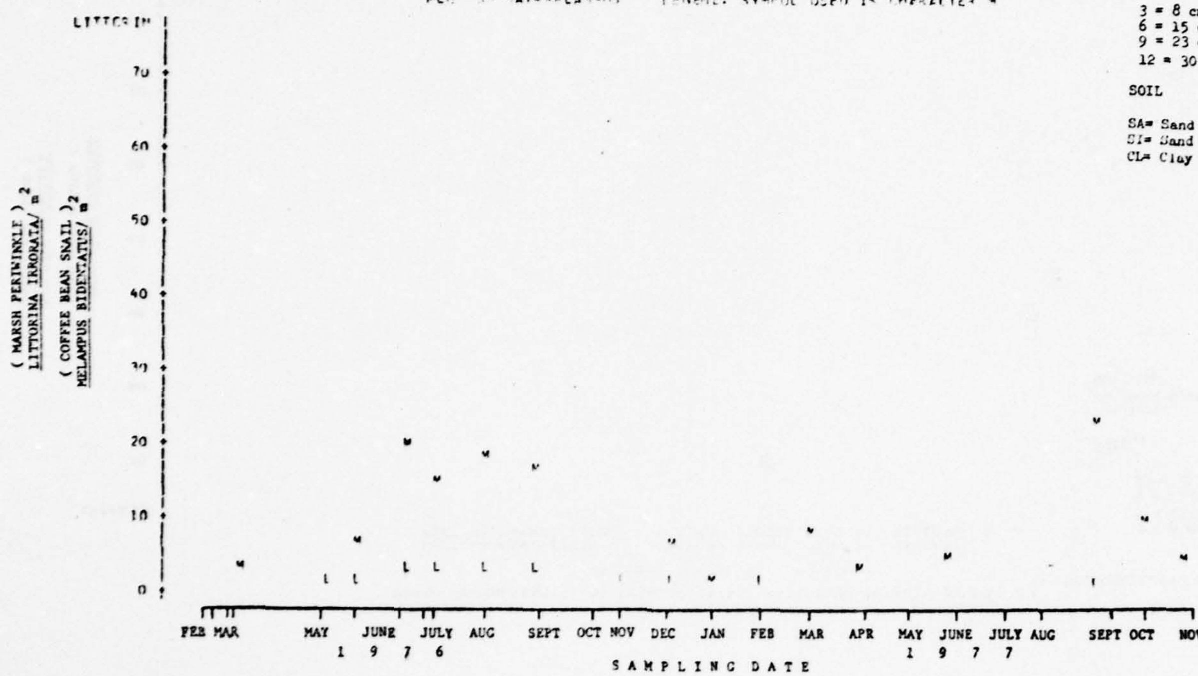
SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

HEIGHT=A SOIL=SI MON=F

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

MON
F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 126
16:22 WEDNESDAY, DECEMBER 21, 1977

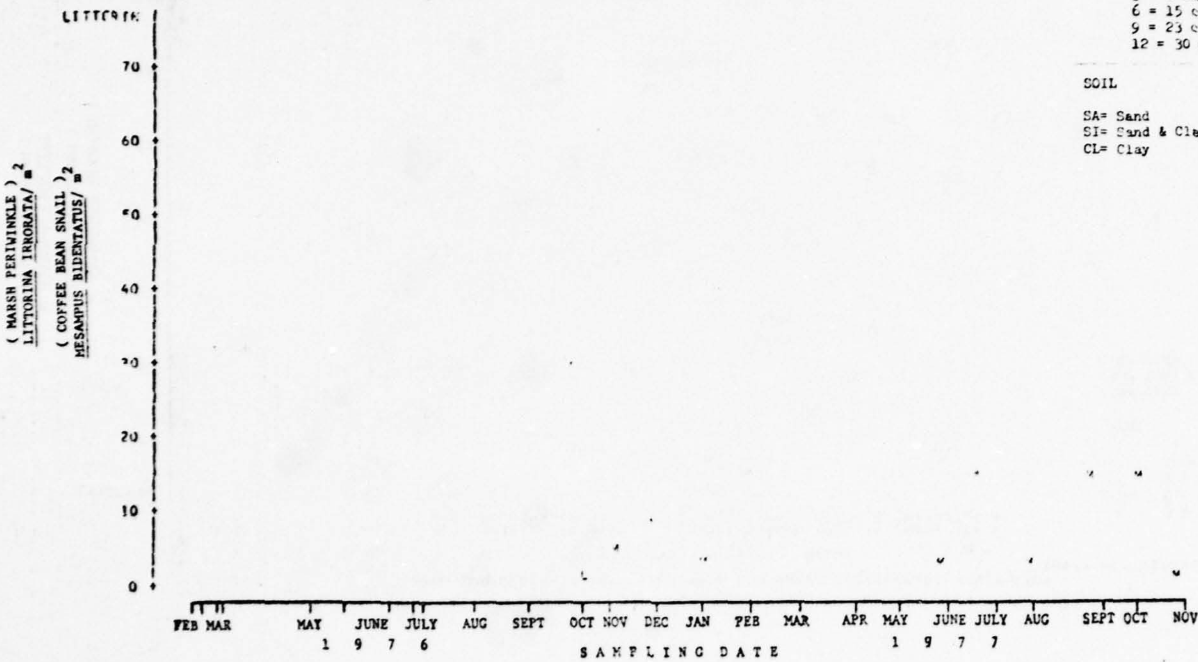
HEIGHT=6 SOIL=SI MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

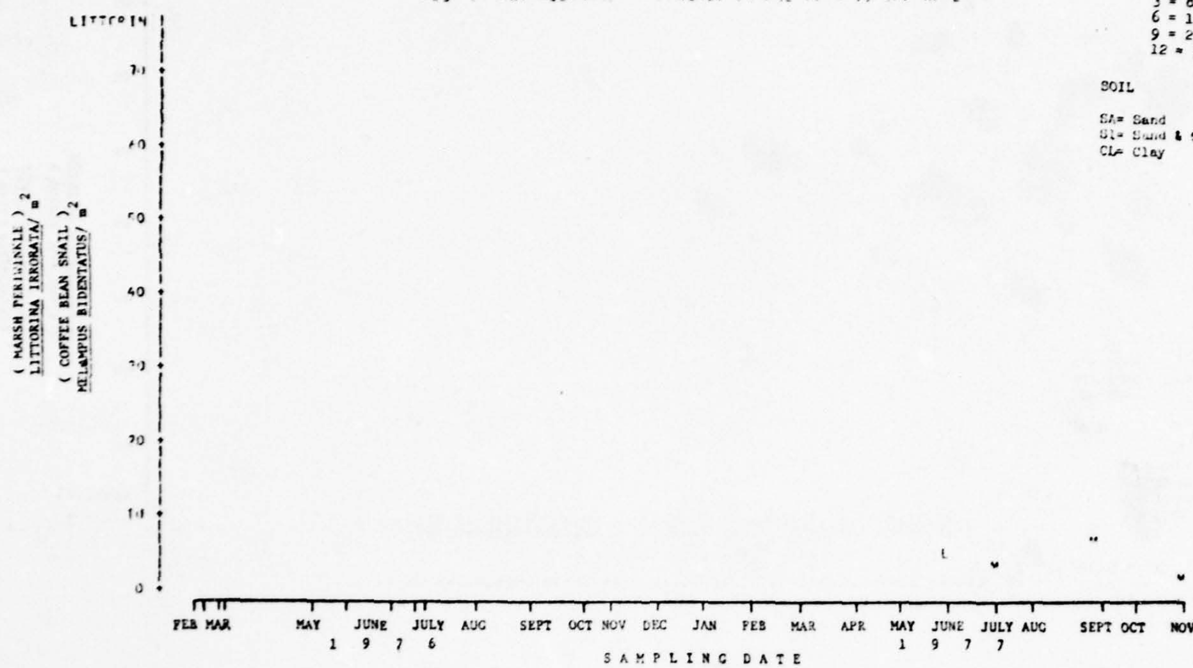
MON
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 127
16:33 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=6 SOIL=SI MON=O

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

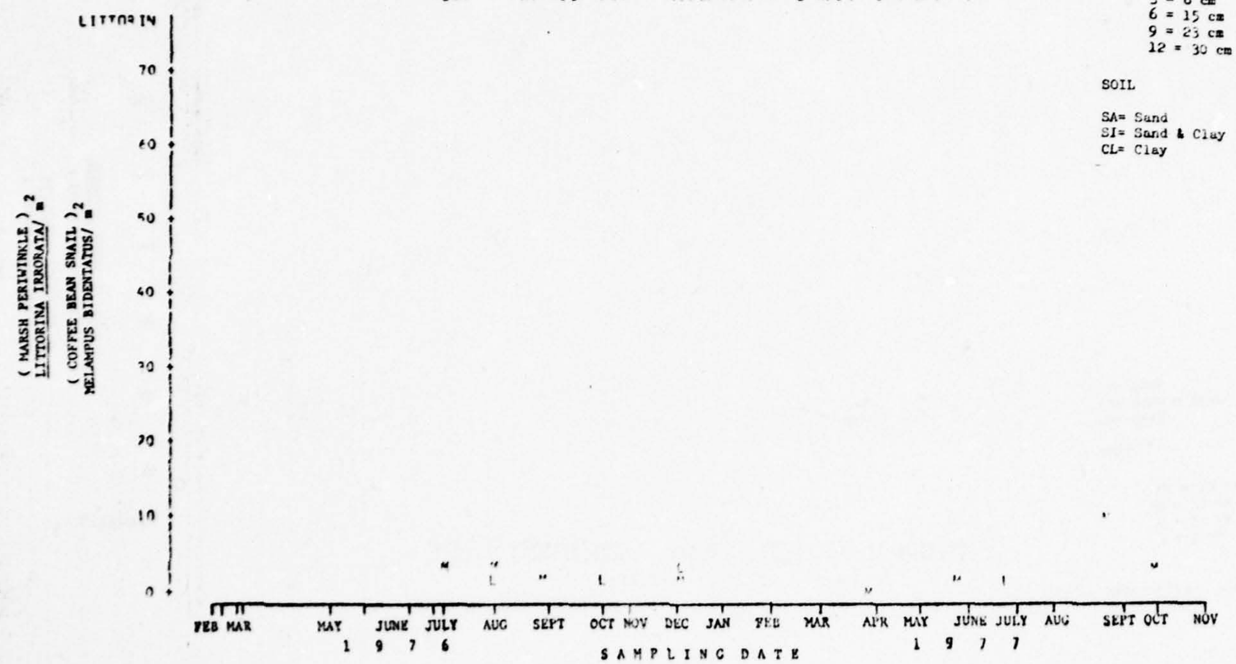
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

MON
F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 128
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=9 SOIL=CL MON=F

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

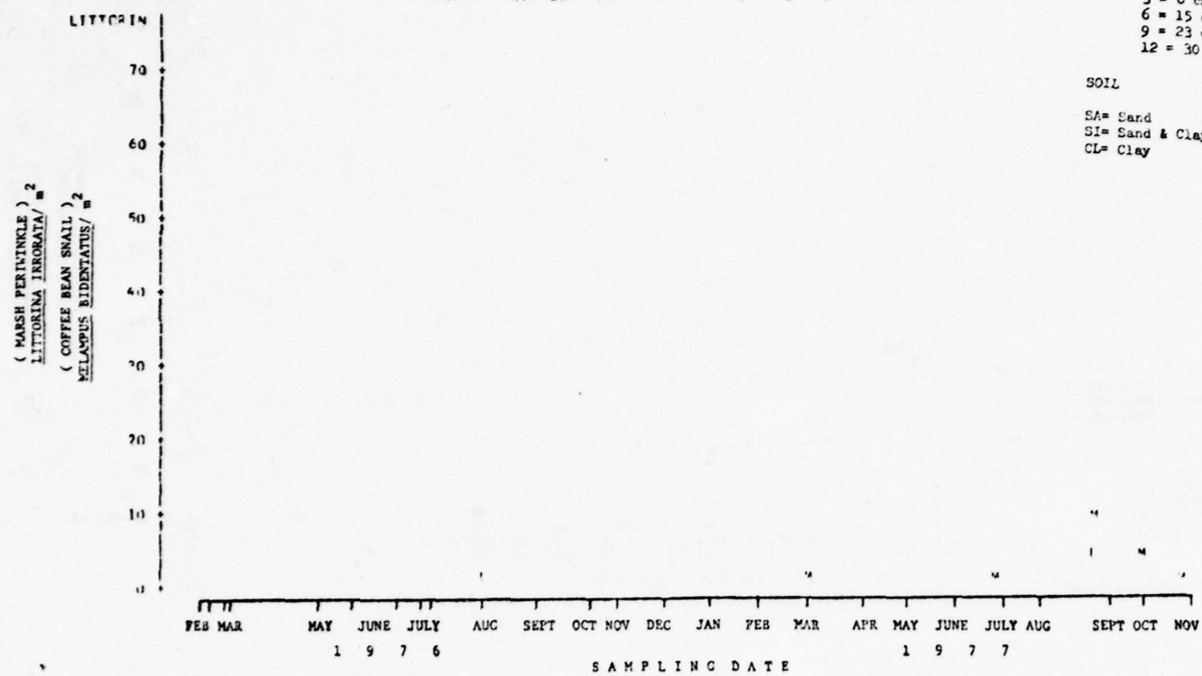
MON
F= February
J= July
O= November

B159

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 129

HEIGHT=9 SOIL=CL MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 139

16:23 WEDNESDAY, DECEMBER 21, 1977

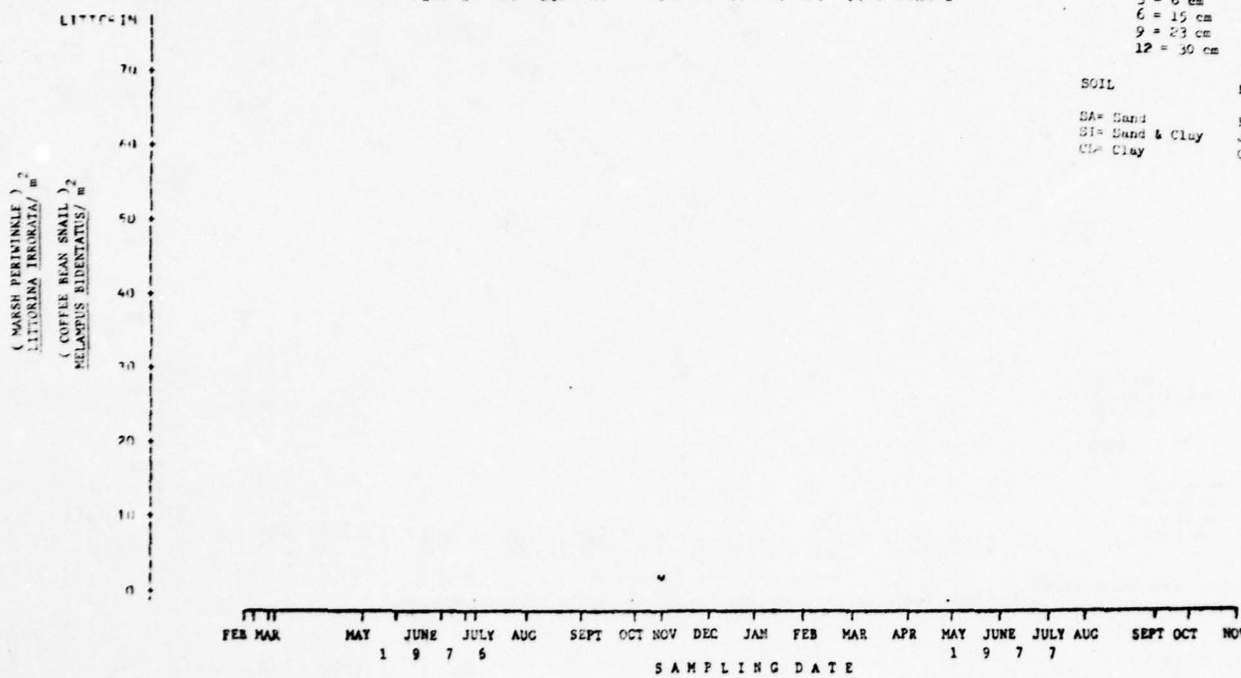
HEIGHT=? SOIL=CL MON=?

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 131

HEIGHT=9 SOIL=SA MON=F

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

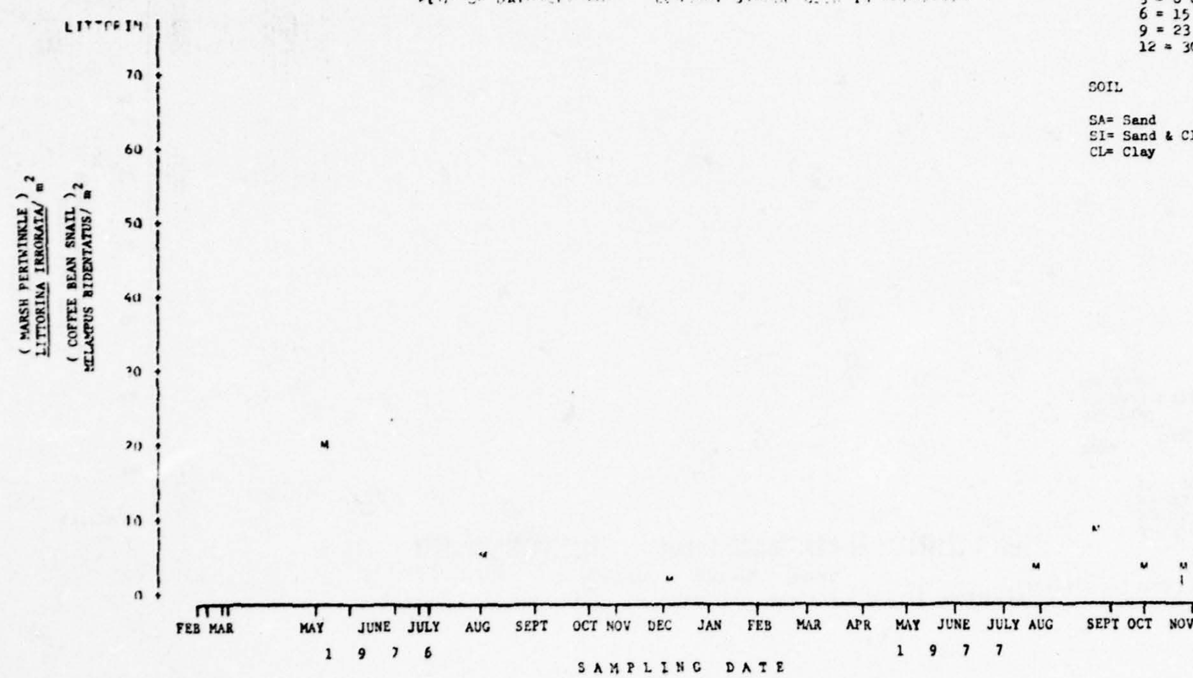
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

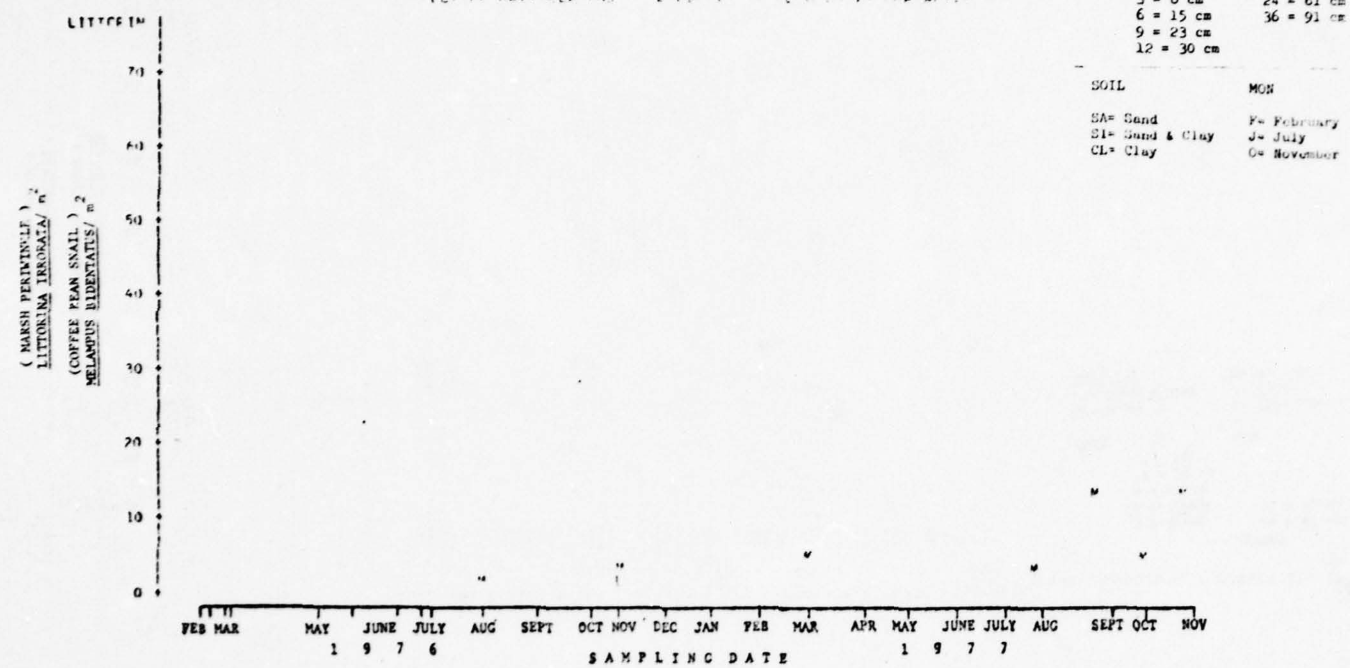
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:22 WEDNESDAY, DECEMBER 21, 1977 132

HEIGHT=6 SOIL=SA MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 133

14:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=6 SOIL=SA MON=O

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

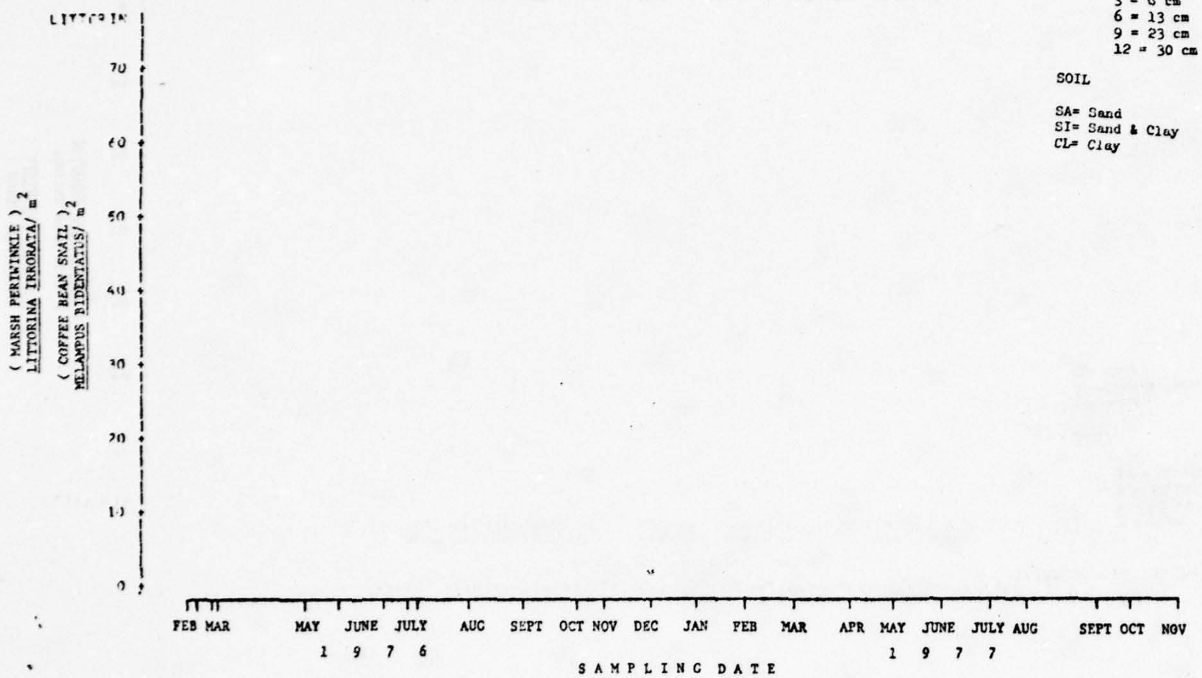
3 = 8 cm
6 = 13 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 134

HEIGHT=9 SOIL=SI MON=F

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

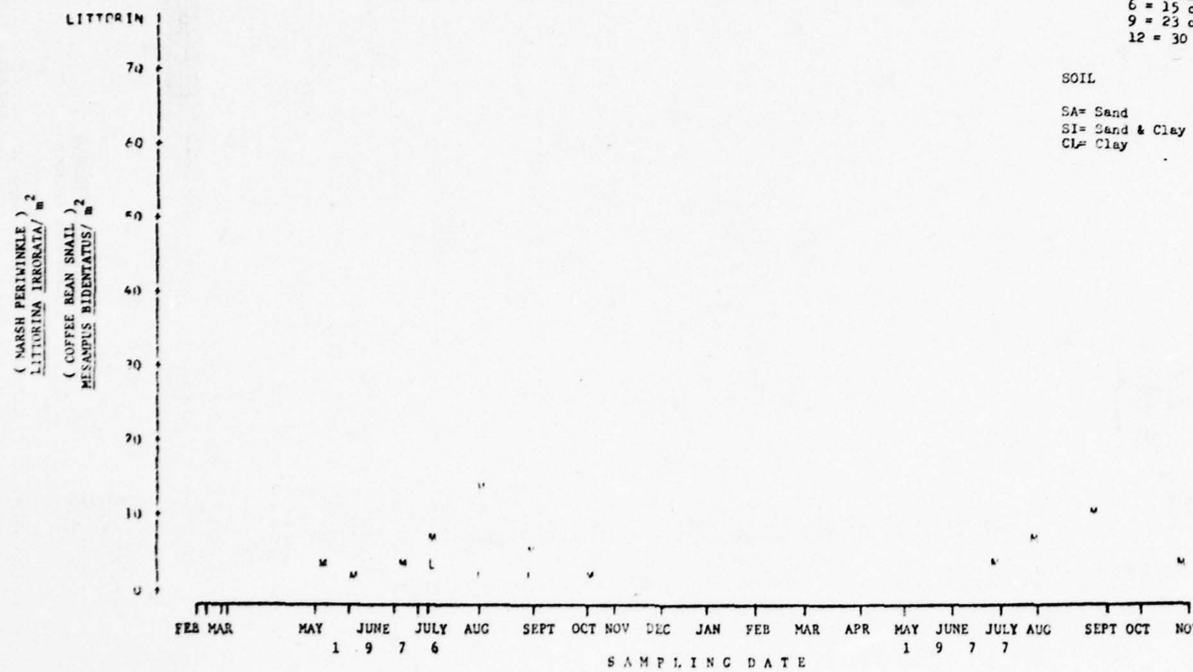
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 135

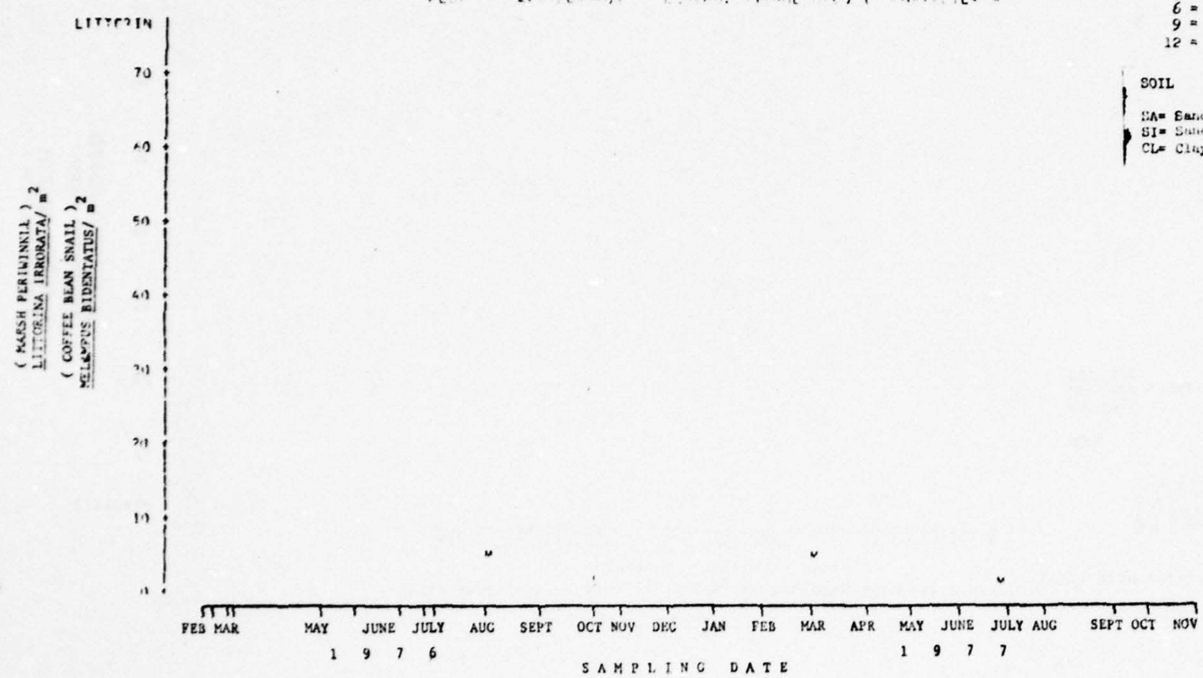
HEIGHT=9 SOIL=SI MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 30 cm

SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 15:23 WEDNESDAY, DECEMBER 21, 1977 136

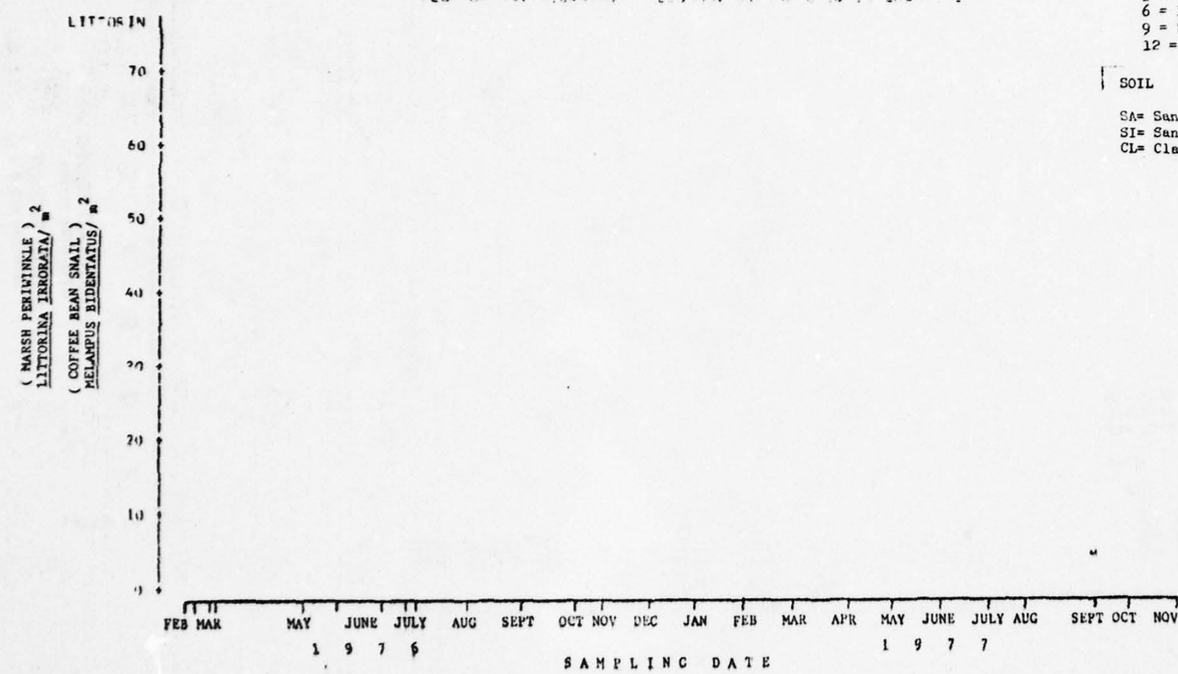
HEIGHT=9 SOIL=SI MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November

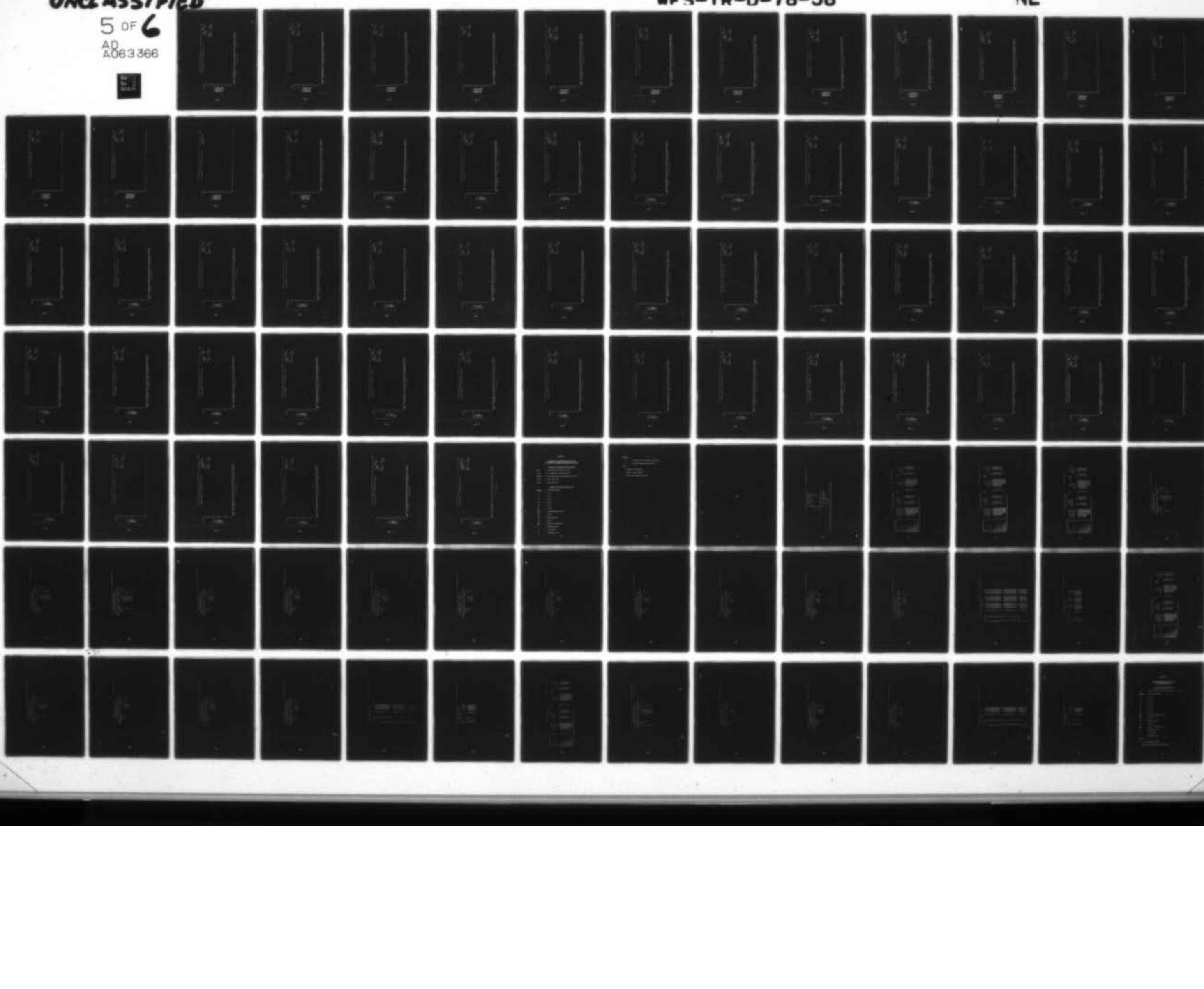


B167

AD-A063 366 GEORGIA UNIV BRUNSWICK MARINE EXTENSION SERVICE F/G 13/2
THE EFFECTS OF SMOTHERING A 'SPARTINA ALTERNIFLORA' SALT MARSH --ETC(U)
JUL 78 R J REIMOLD, M A HARDISKY, P C ADAMS DACW21-75-C-0074

UNCLASSIFIED WES-TR-D-78-38 NL

5 OF 6
AD
A063366



ASSIFI

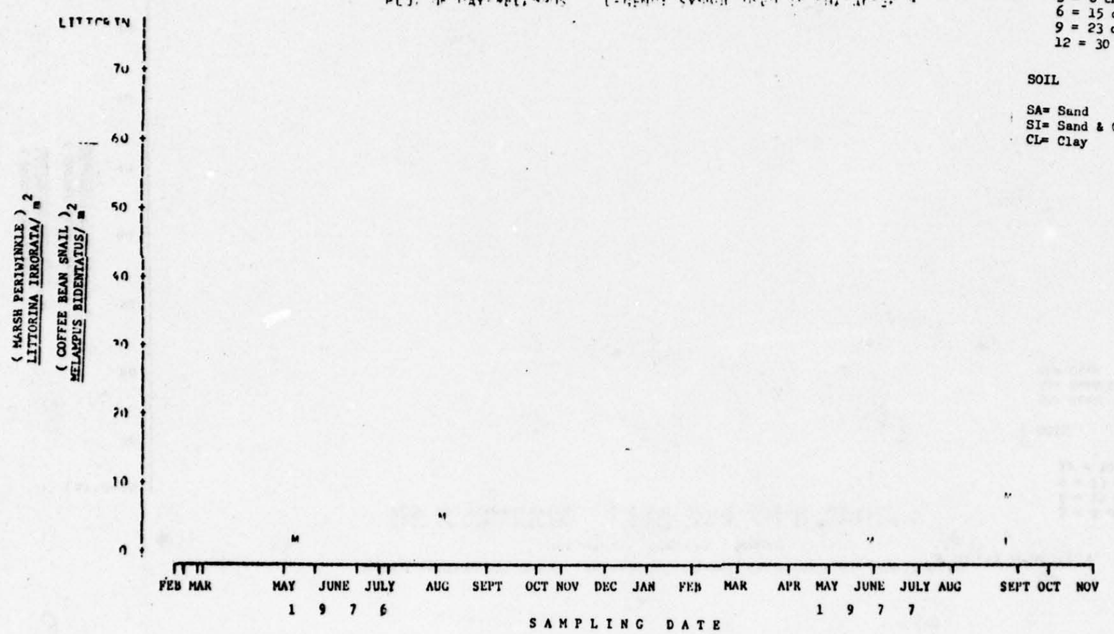
5 OF 6

AD
A063366

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 137
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=12 SOIL=CL MON=F

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 138

HEIGHT=12 SOIL=CL MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

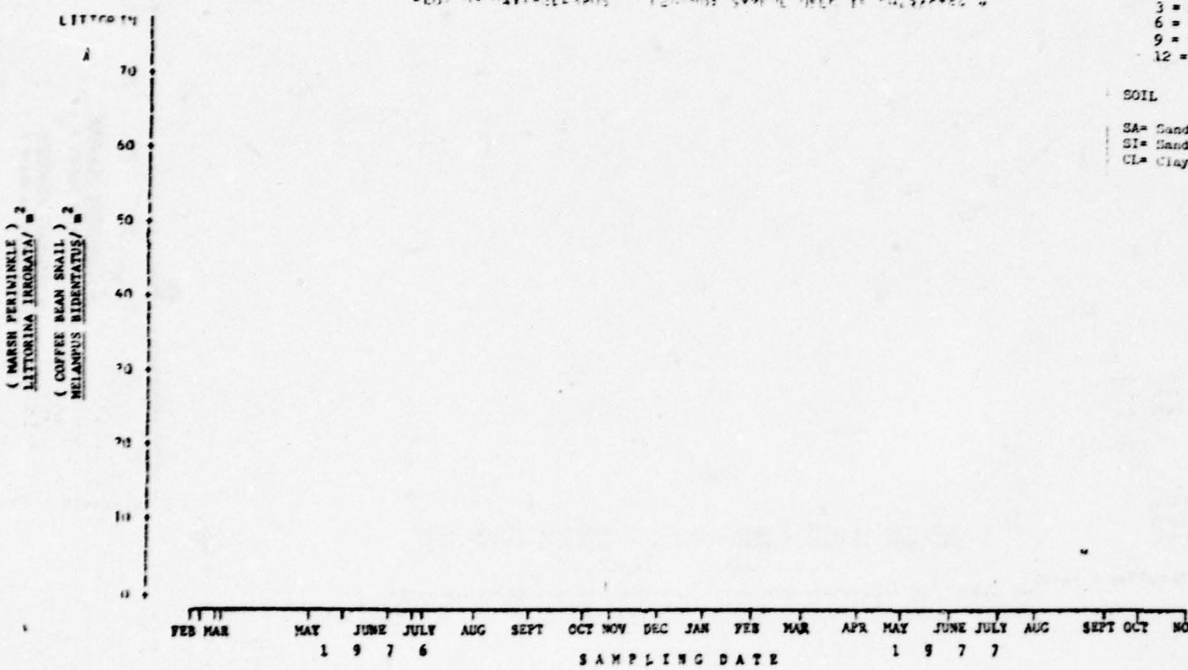
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

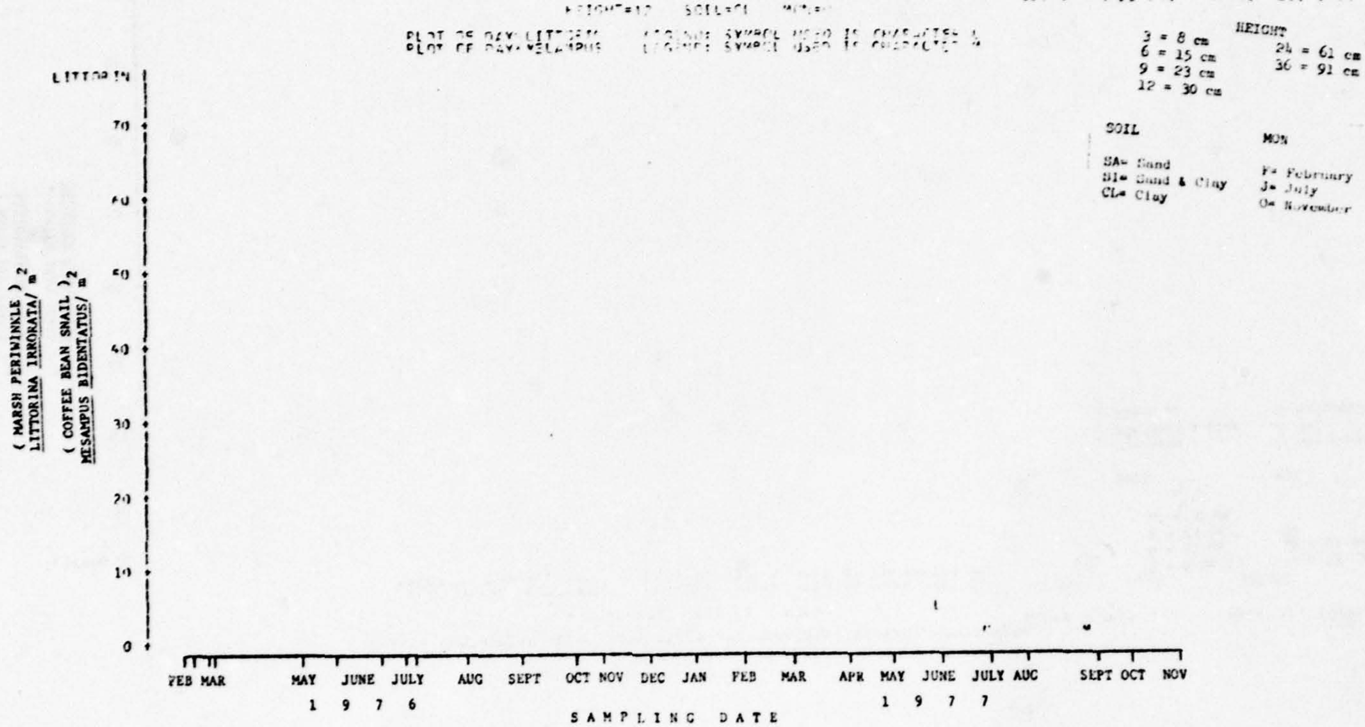
MON

F= February
J= July
O= November



HEIGHT=12 SOIL=CL MON=

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 140
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=12 SOIL=SA MON=F

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER 1
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER 4

HEIGHT

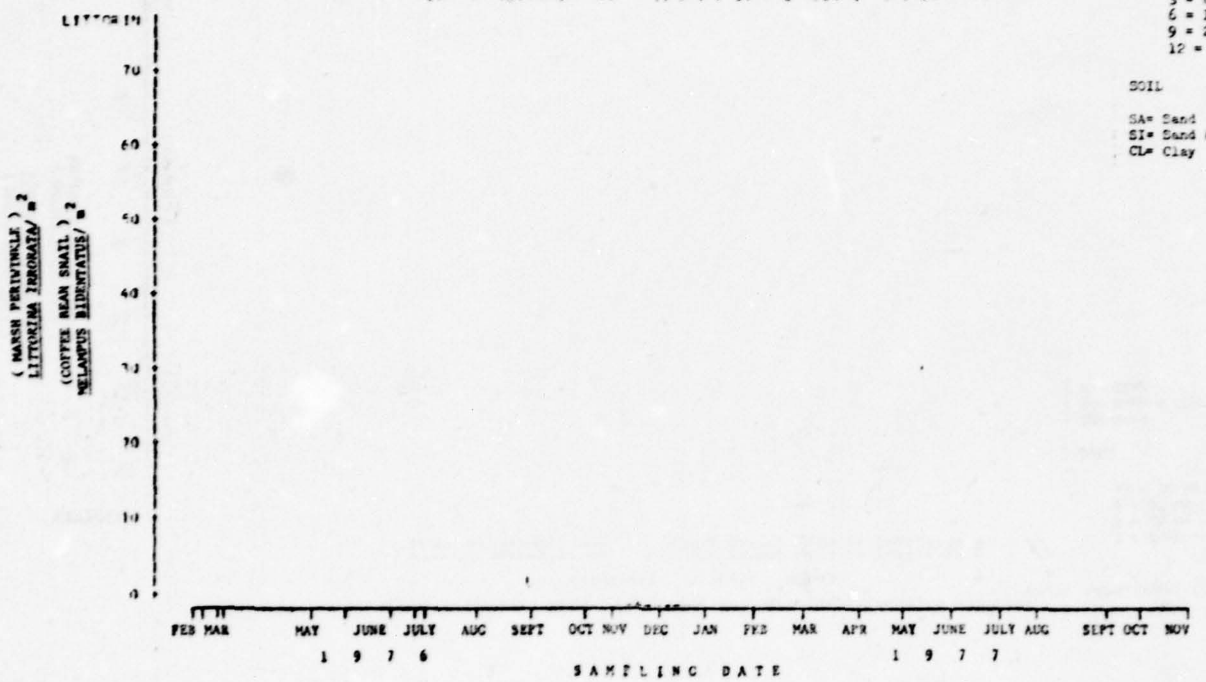
3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 30 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

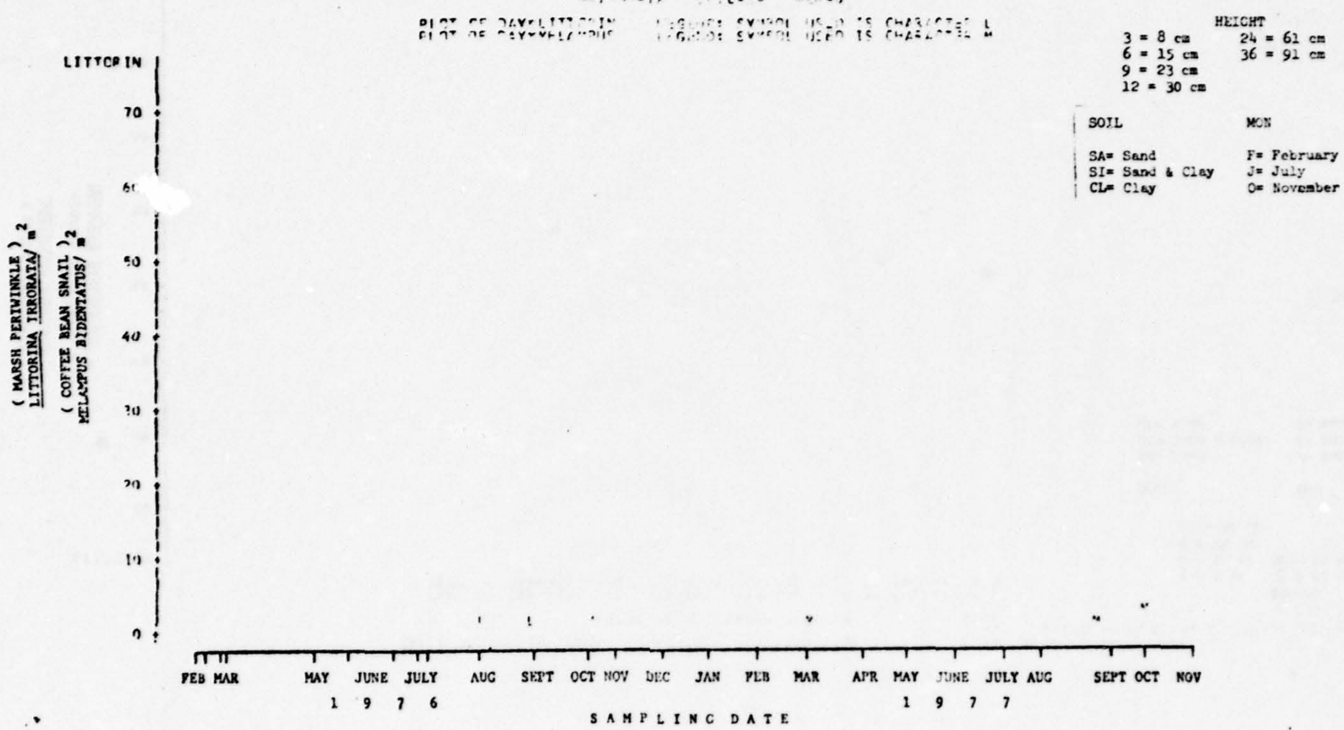


B171

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 141

HEIGHT=12 SOIL=SA MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



MARSH ESTABLISHING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 142

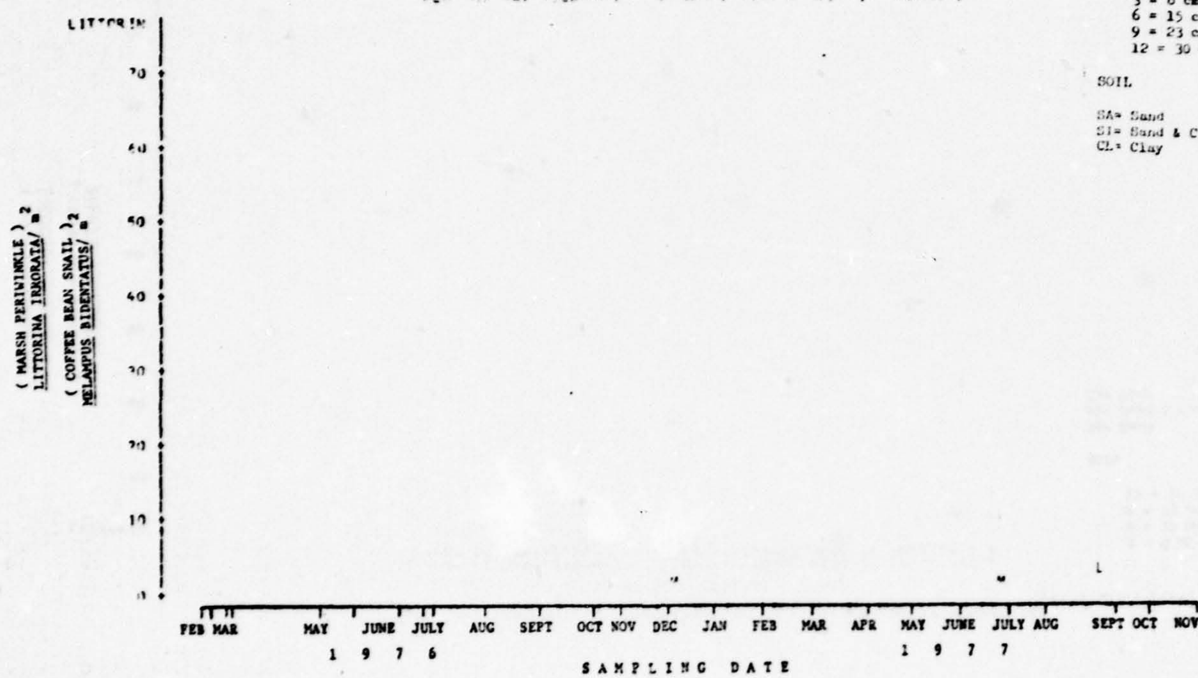
HEIGHT=12 SOIL=SA

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS

PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS

HEIGHT	
3 = 8 cm	24 = 61 cm
6 = 15 cm	36 = 91 cm
9 = 23 cm	
12 = 30 cm	

SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November

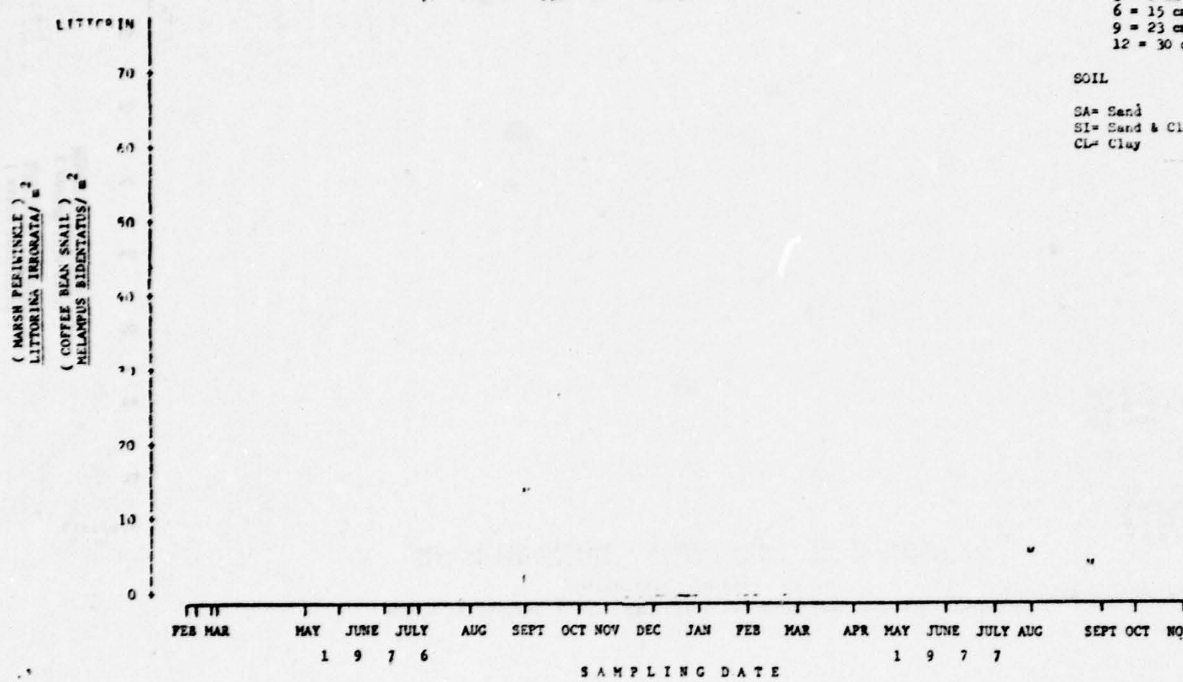


B173

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 143
16:33 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=12 SOIL=SI MON=F

PLOT OF DAY LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING
10:23 WEDNESDAY, DECEMBER 21, 1977 144

HEIGHT=12 SOIL=SI MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

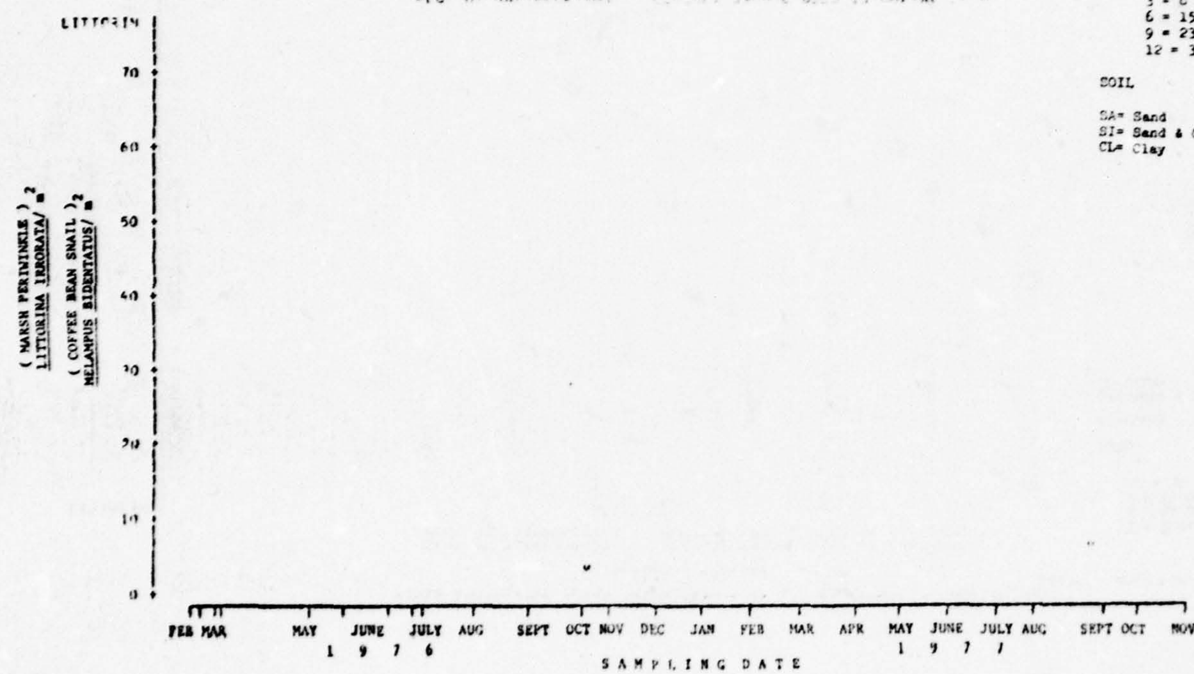
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

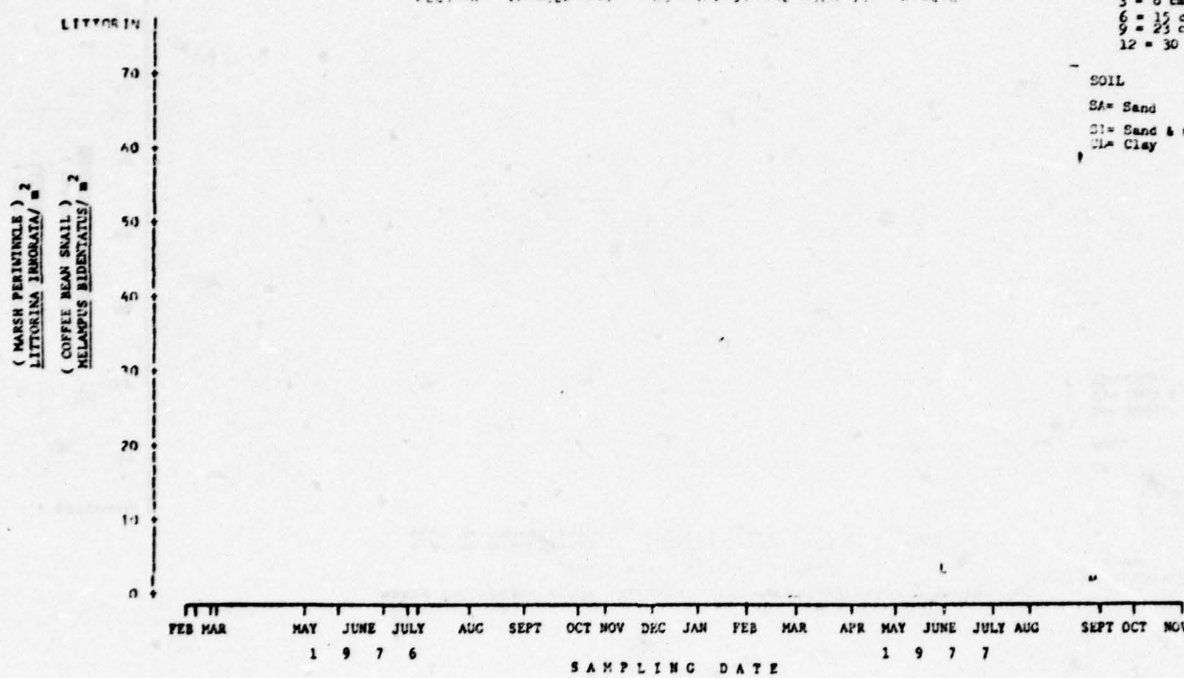
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 145
16:37 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=12 SOIL=SI MON=?

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M



HEIGHT

3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 30 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 146
16:23 WEDNESDAY, DECEMBER 21, 1977

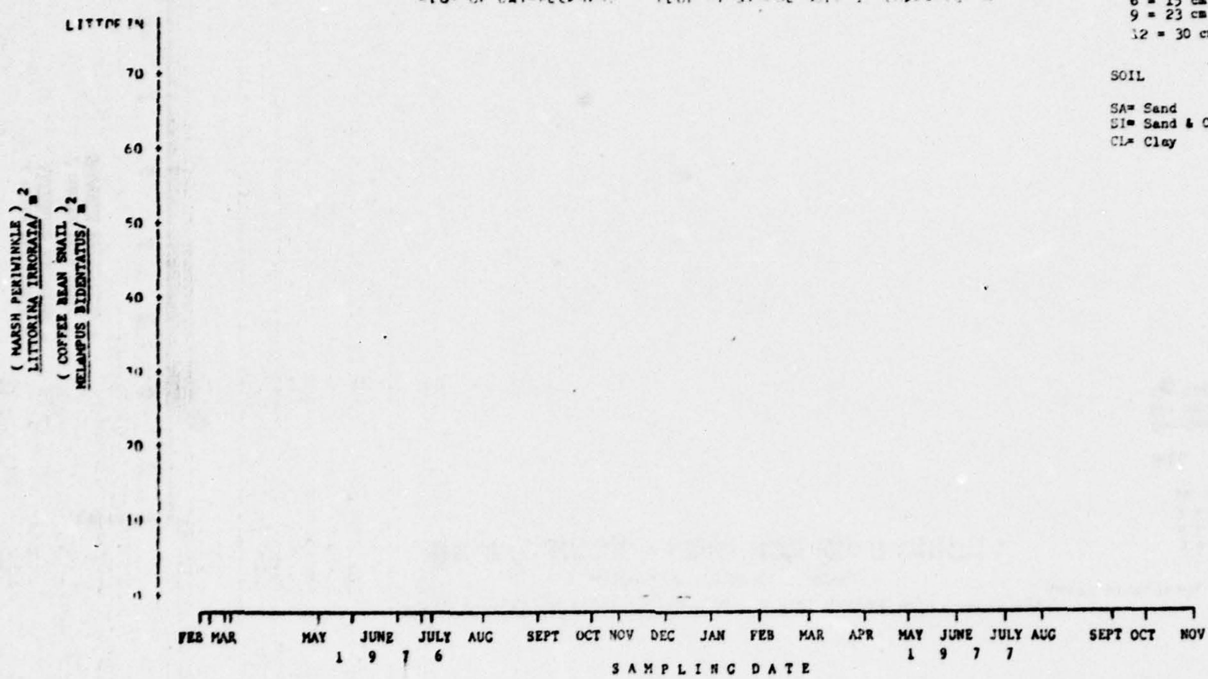
HEIGHT=24 SOIL=CL MON=F

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERT DEAT MONITORING 167
16:22 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=24 SOIL=CL MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

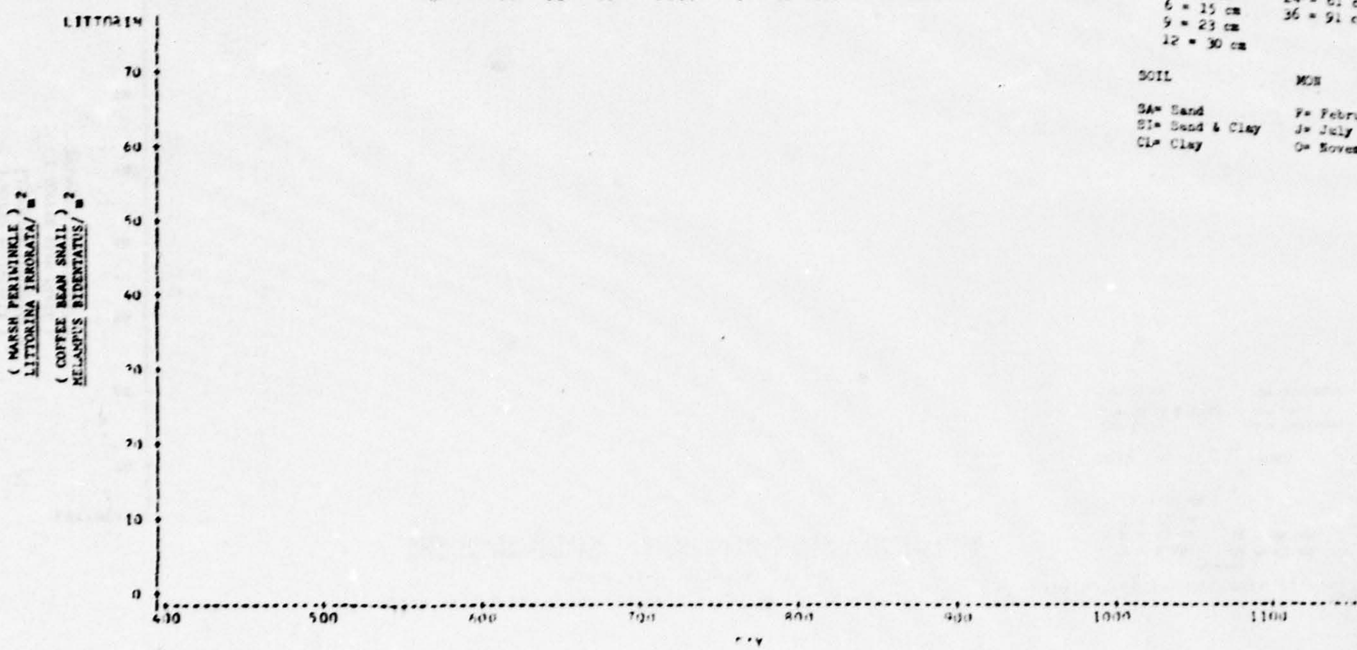
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



B178

MARSH SYNTHETIC PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 148

14:23 THURSDAY, DECEMBER 21, 1977

HEIGHT=24 SOIL=CL MON=O

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

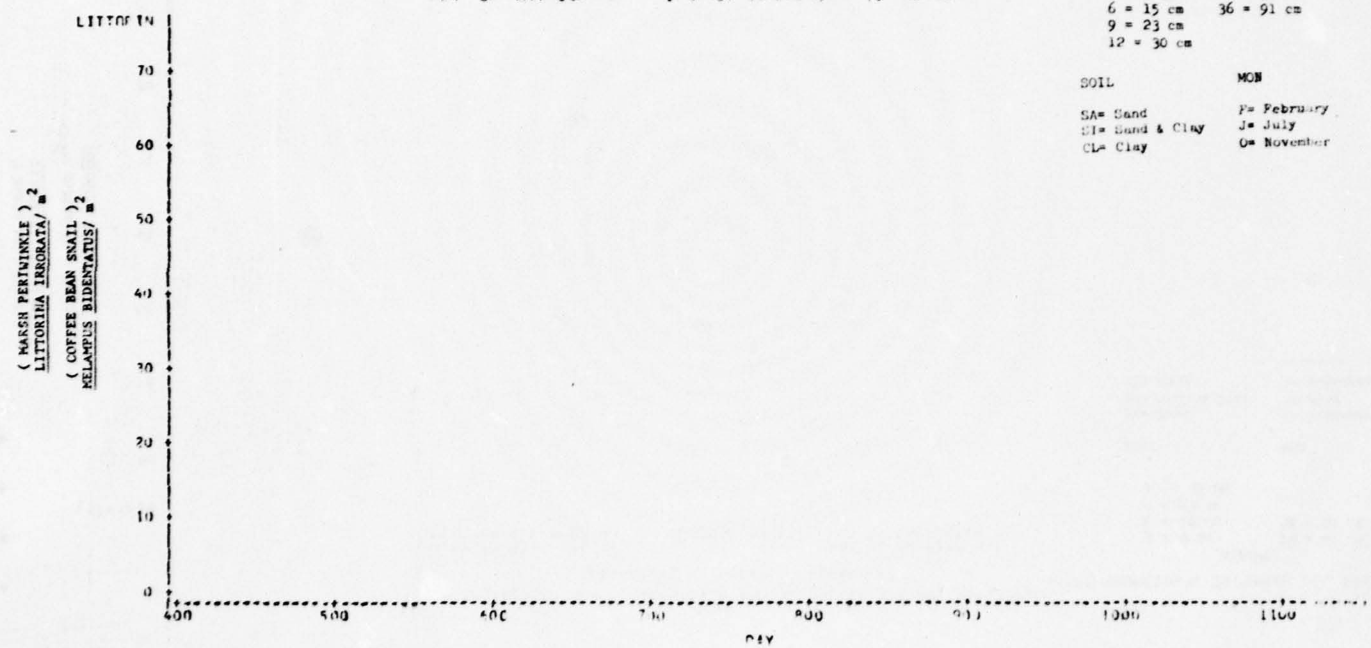
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



B179

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 149

HEIGHT=24 SOIL=SI MON=F

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

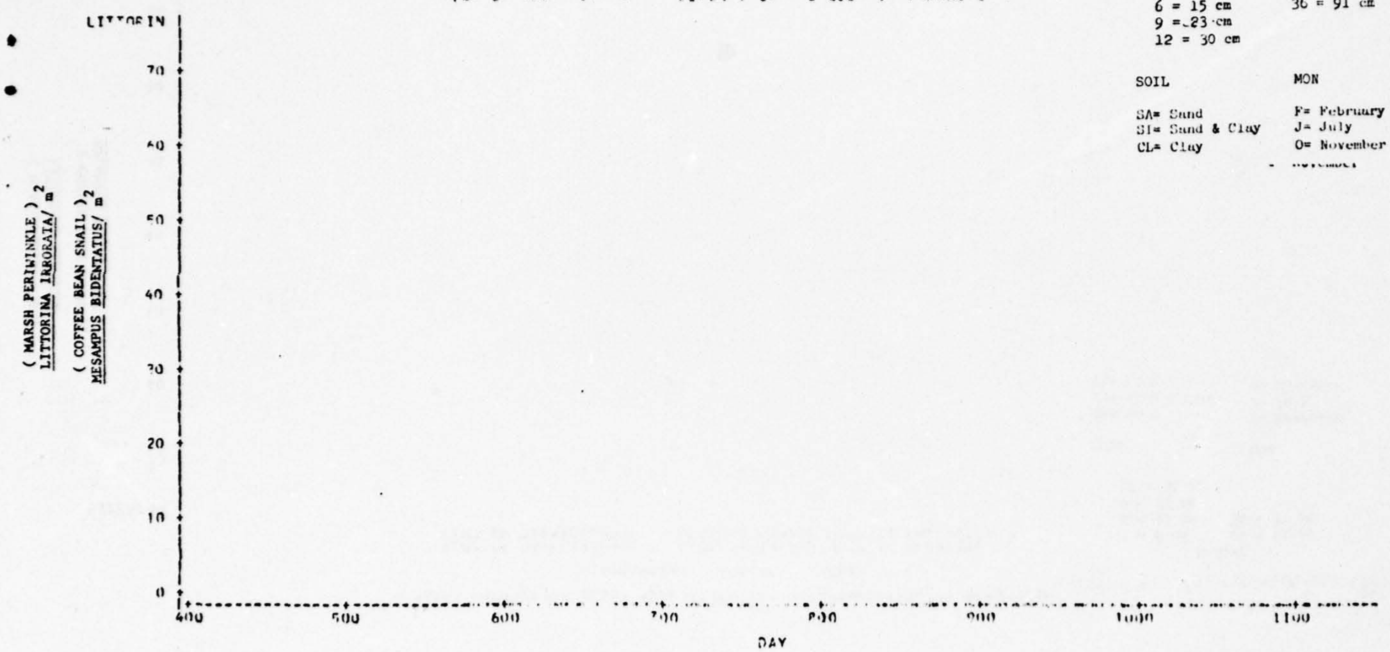
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 150

HEIGHT=24 SOIL=SA MON=J

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER 1
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER 2

HEIGHT

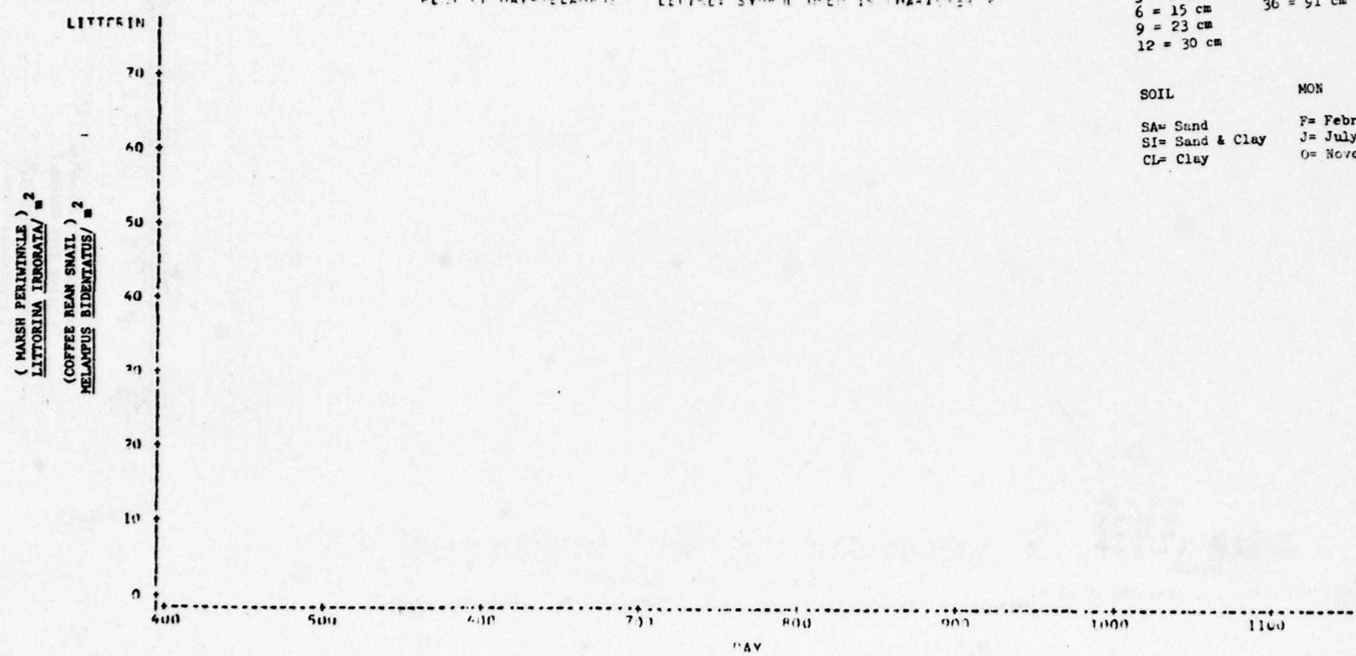
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



B181

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 151

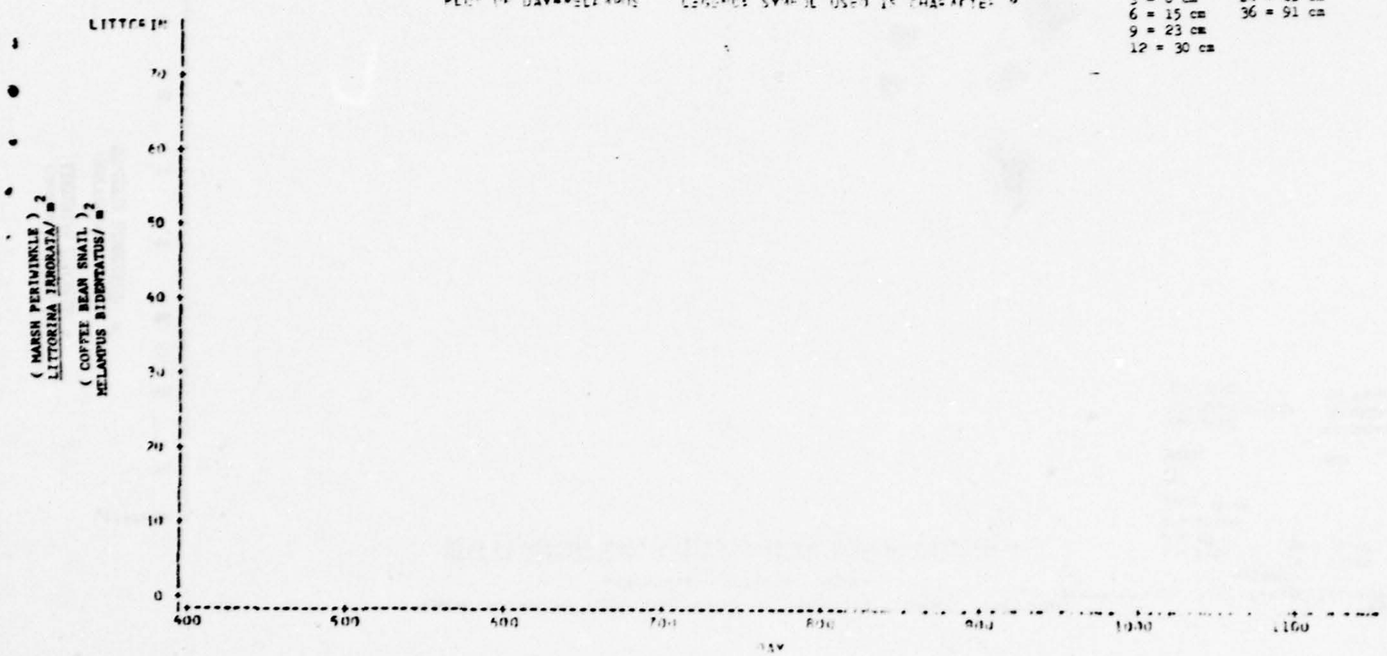
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=24 SOIL=S MOUND

PLOT OF DAY*LITTORIN LEGEND: SYMBOL USED IS CHARACTER L
PLOT OF DAY*MELAMPUS LEGEND: SYMBOL USED IS CHARACTER M

HEIGHT

3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 30 cm



MARSH SMOOTHING PLANT [illegible] 16:23 WEDNESDAY, DECEMBER 21, 1977 158

[illegible]

PLOT OF DAY*LITTORIN [illegible]
PLOT OF DAY*MELAMPUS [illegible]

HEIGHT

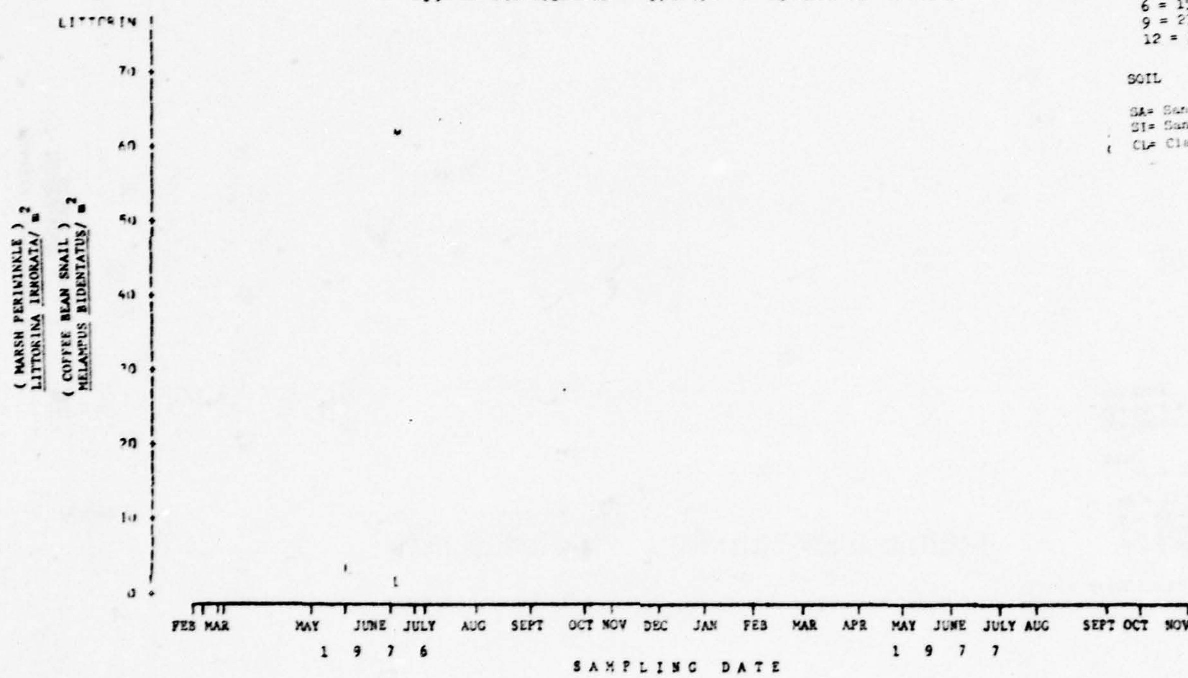
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING   16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=3 SOIL=CL MON=F

PLOT OF DAY*FLOWERIN   LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING   LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT

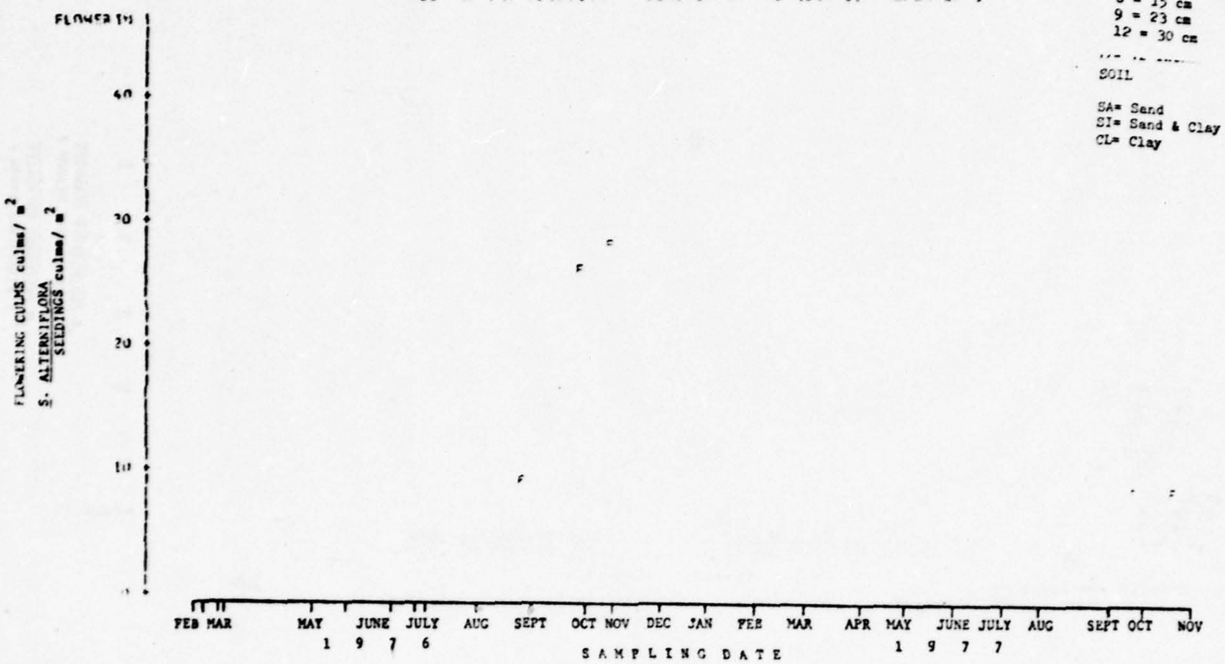
3 = 8 cm   24 = 61 cm
6 = 15 cm   36 = 91 cm
9 = 23 cm
12 = 30 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

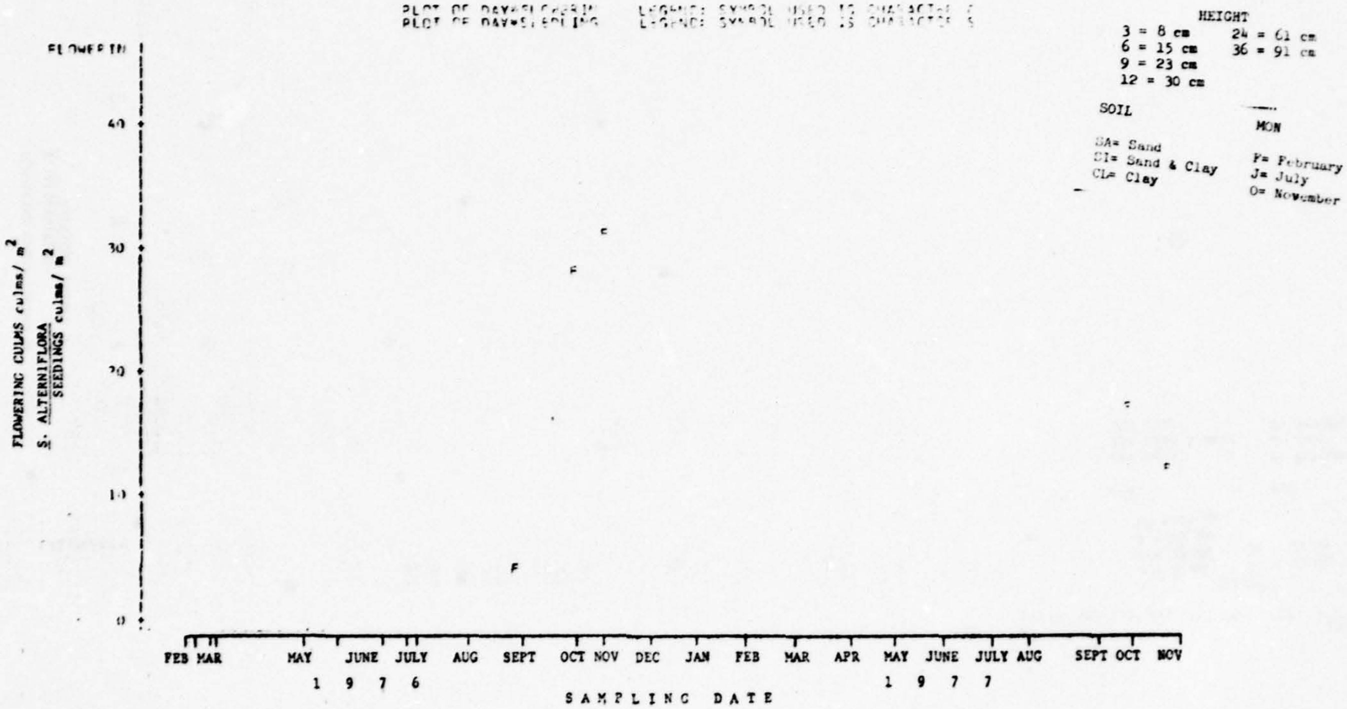
MON

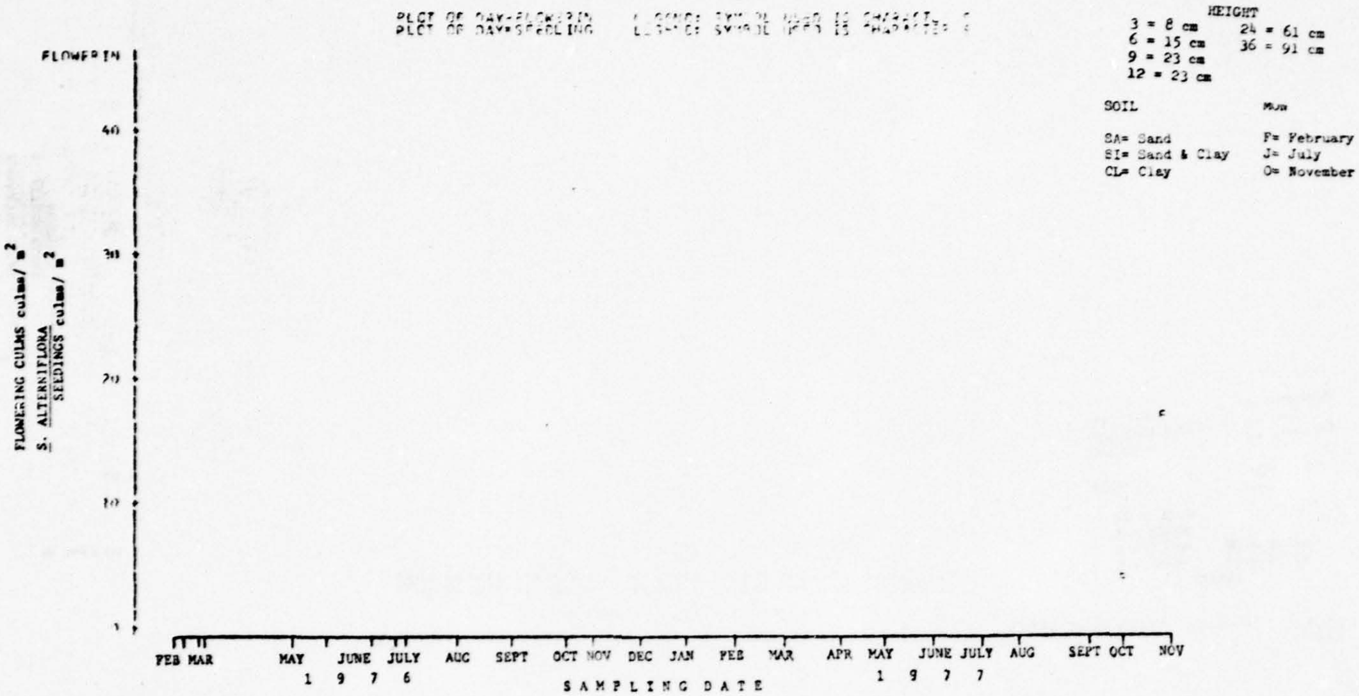
F= February
J= July
O= November



HEIGHT=3 SOIL=CL MON=J

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S




FLOWERIN
40
30
20
10
FLOWERING CULMS culms/m²
S. ALTERNIFLORA SEEDINGS culms/m²
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE
HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 23 cm
24 = 61 cm
36 = 91 cm
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay
F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 167

HEIGHT=3 SOIL=SA MON=F

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT

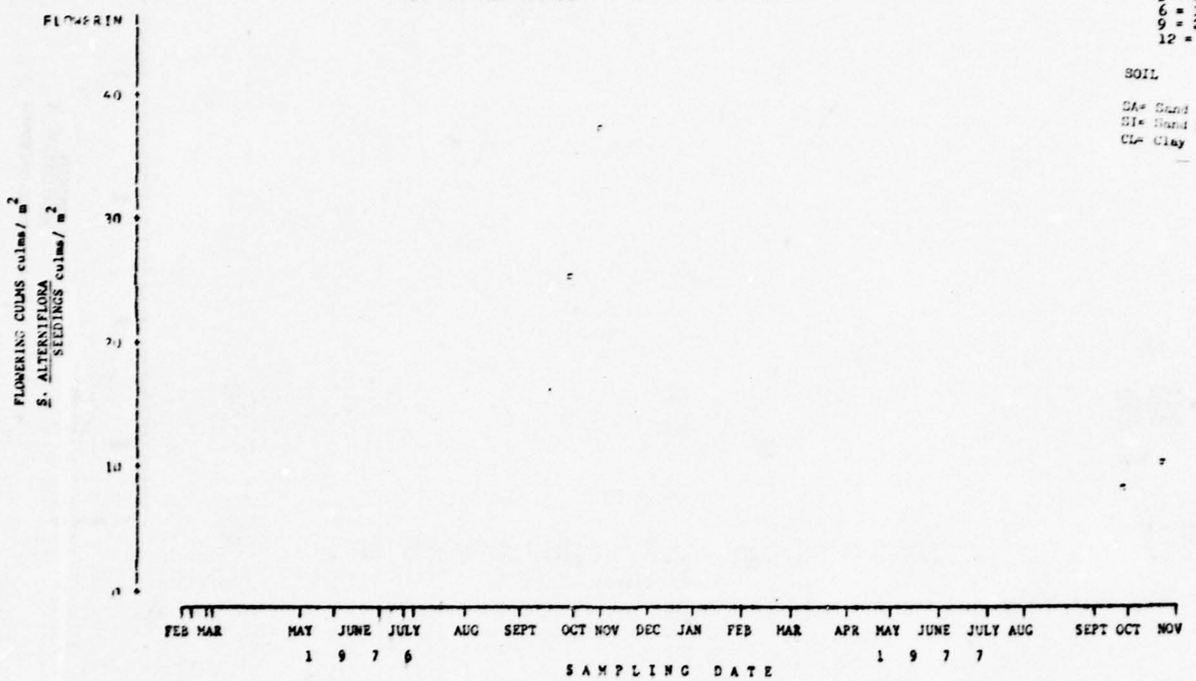
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



B187

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 169

HEIGHT=3 SOIL=SL MON=J

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT

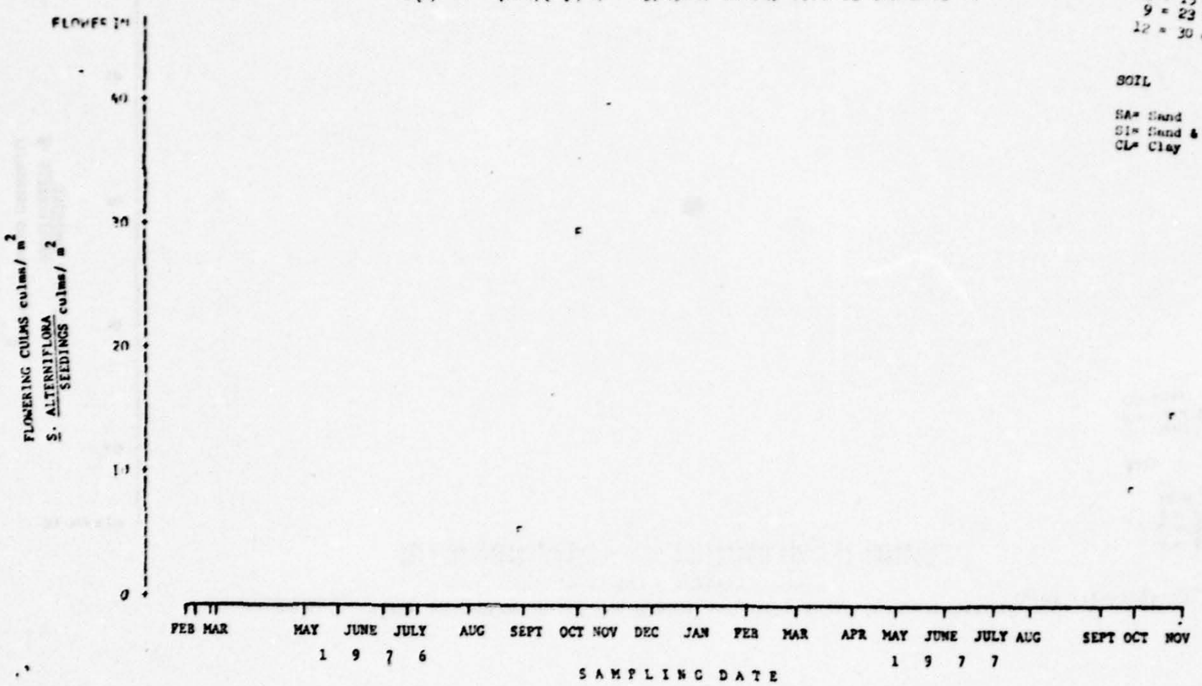
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



B188

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 169
16:23 WEDNESDAY, DECEMBER 21, 1977

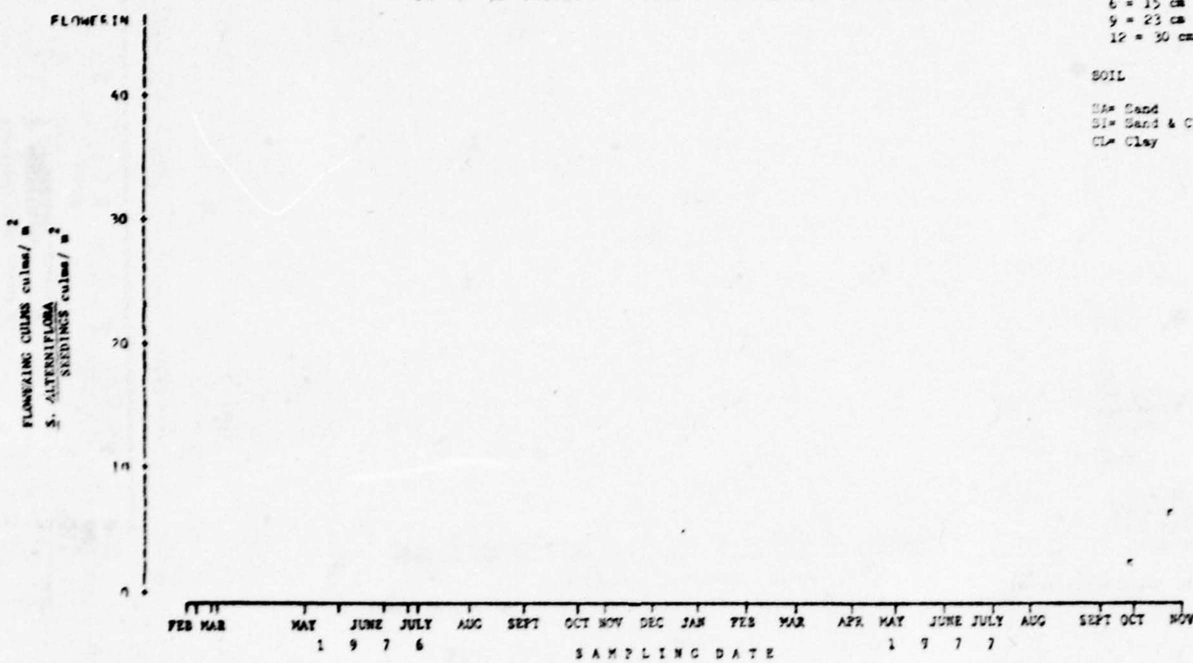
HEIGHT=3 SOIL=SA MON=F

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT

3 = 8 cm	24 = 61 cm
6 = 15 cm	36 = 91 cm
9 = 23 cm	
12 = 30 cm	

SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November



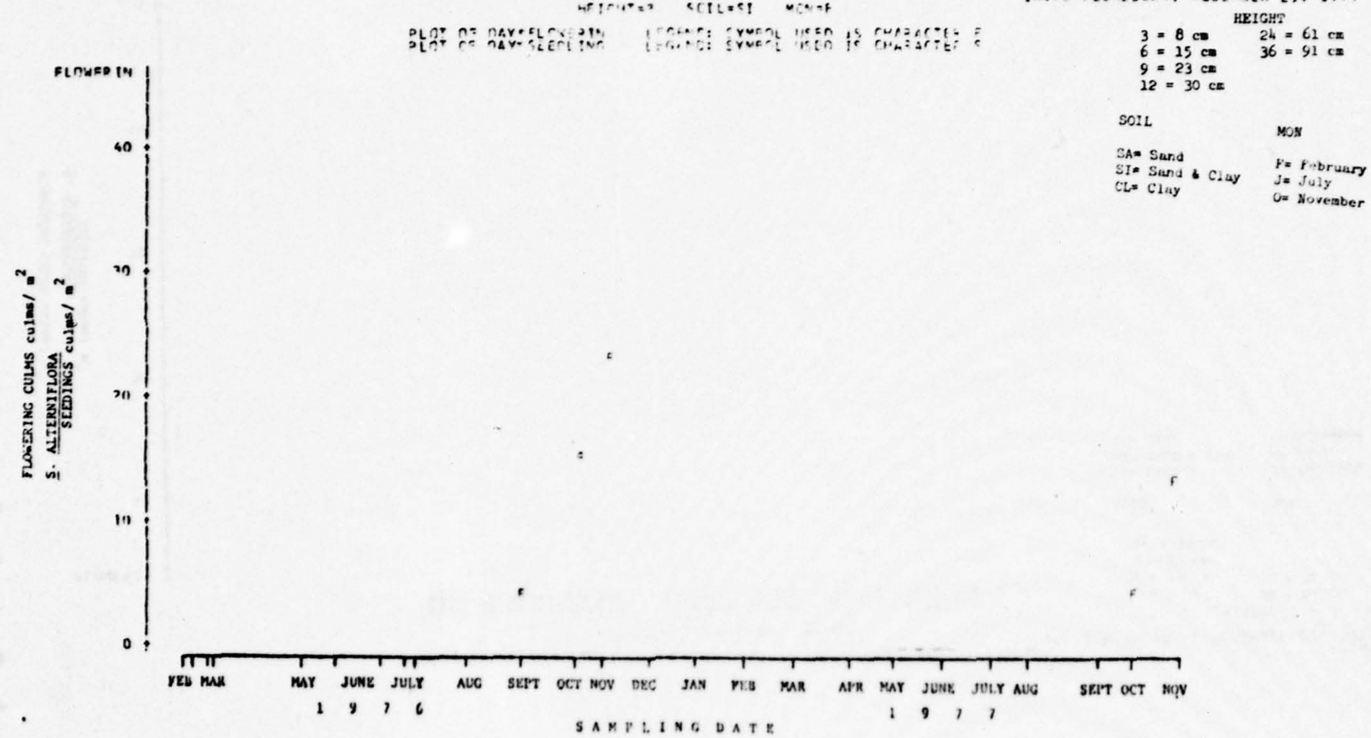
B189

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 170

14:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=? SOIL=SI MON=F

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

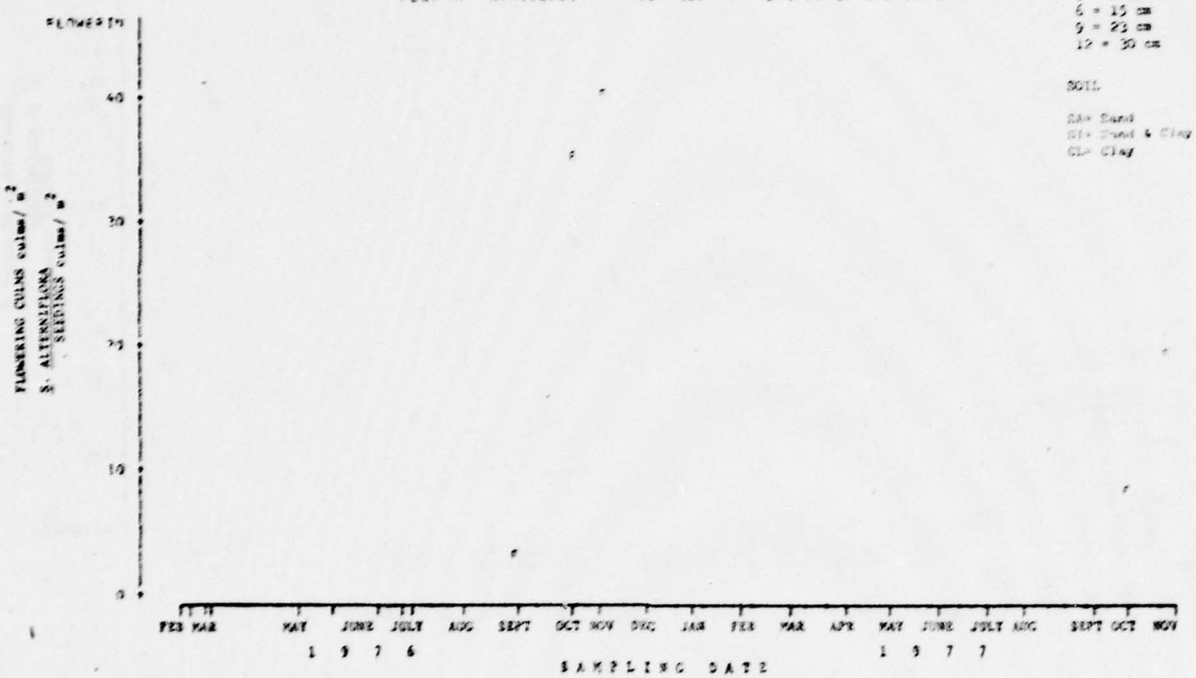


B190

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 171
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=3 SOIL=SI MON=J

PLOT OF FAV*FLOWERS LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF FAV*SEEDLING LEGEND: SYMBOL USED IS CHARACTER [illegible]



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

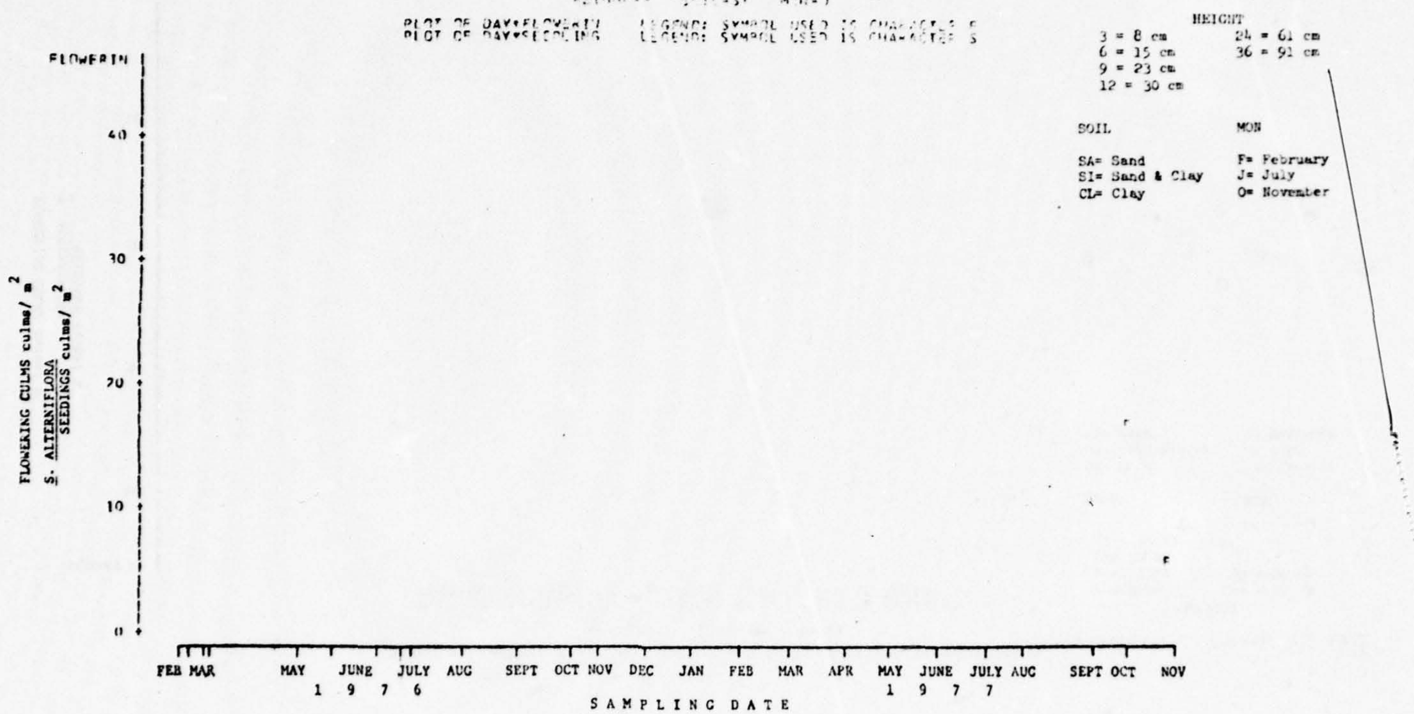
F= February
J= July
O= November

B191

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 172
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=3 SOIL=SI MON=J

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 173
16:23 WEDNESDAY, DECEMBER 21, 1977

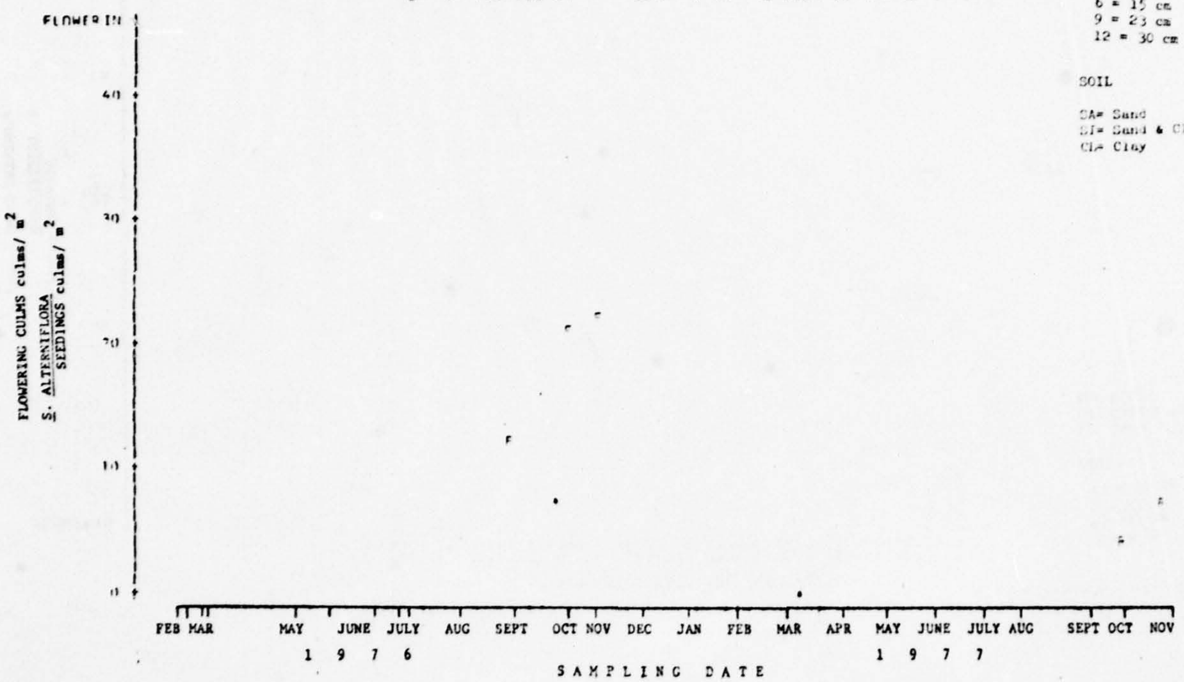
HEIGHT=6 SOIL=CL MON=F

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

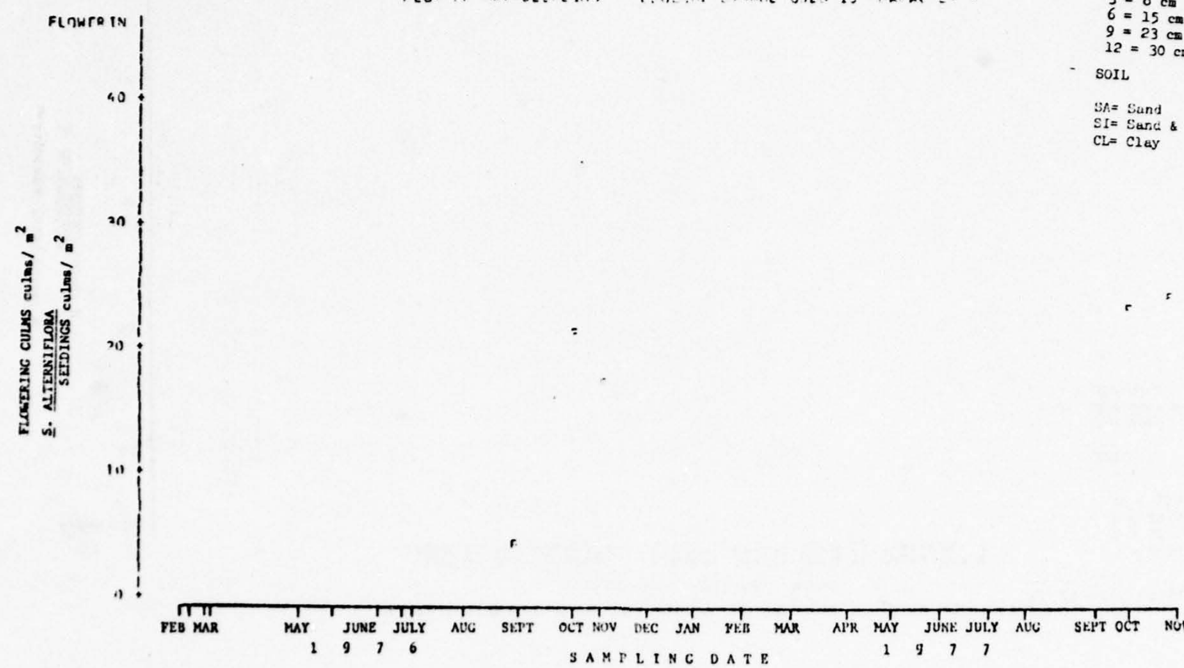
MON
F= February
J= July
O= November



B193

HEIGHT=6 SOIL=CL MON=J

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING

16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=6 SOIL=CL MON=O

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT

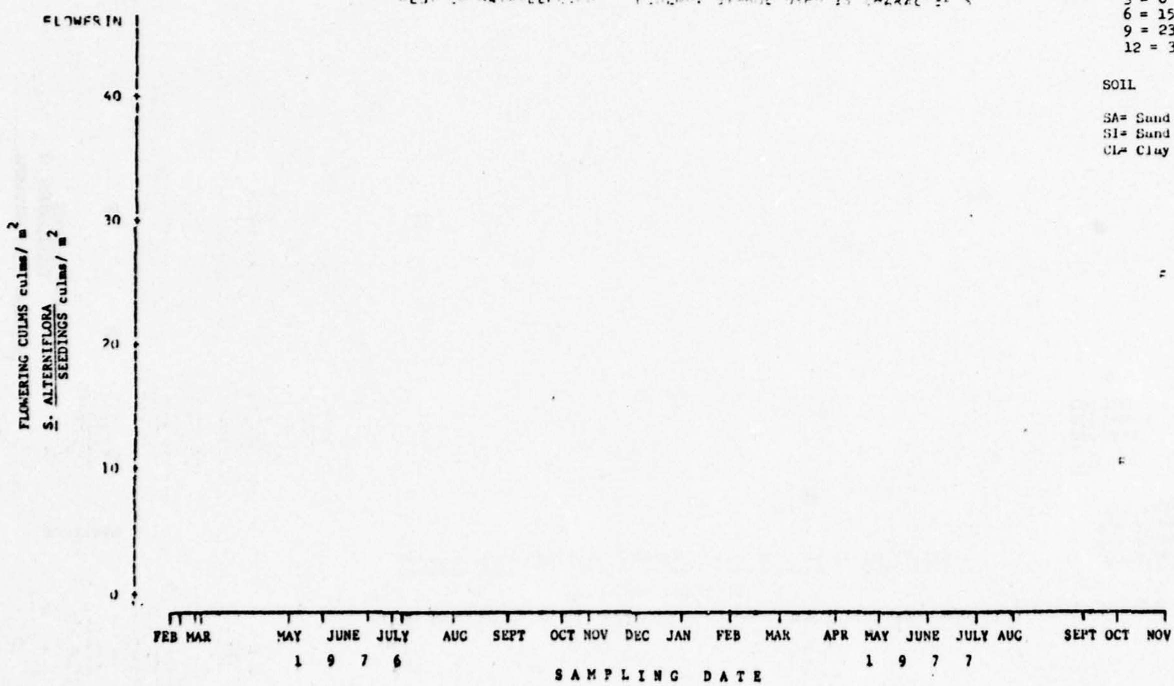
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

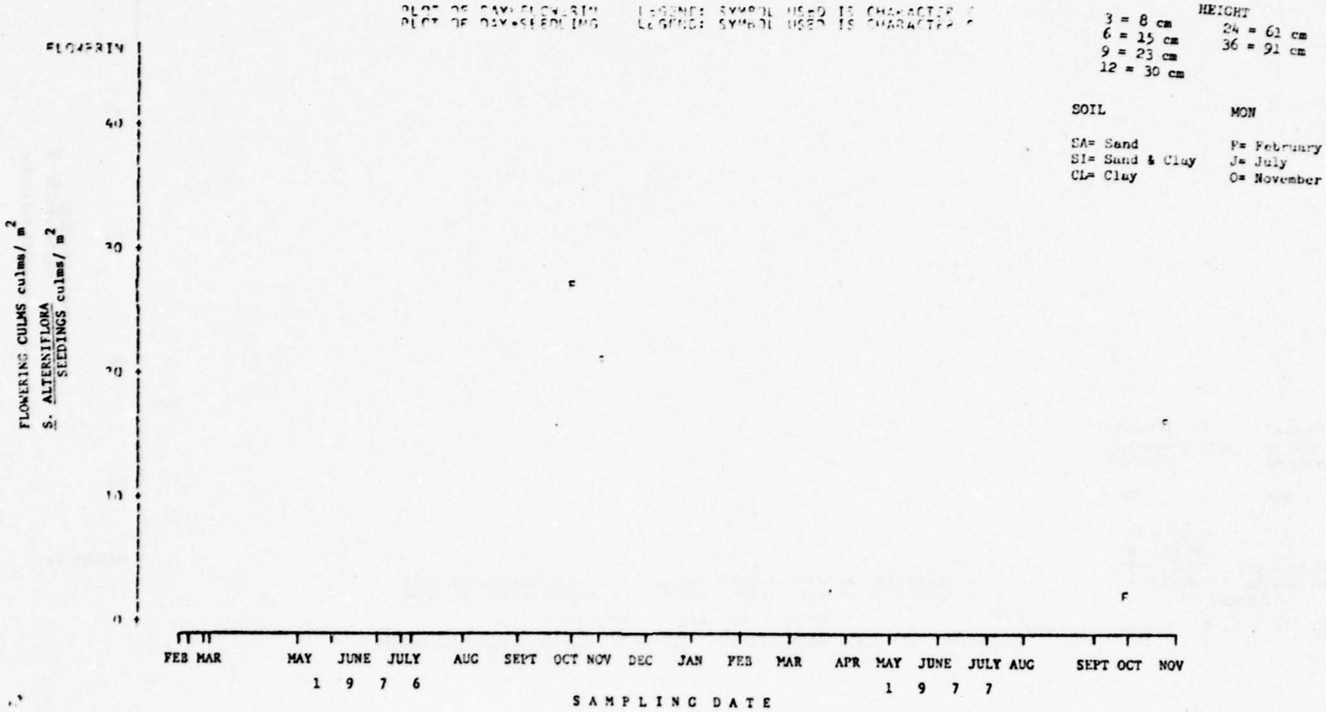


MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 176

16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=6 SOIL=SA MON=F

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER F



HEIGHT=6 SOIL=SA MON=J

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT

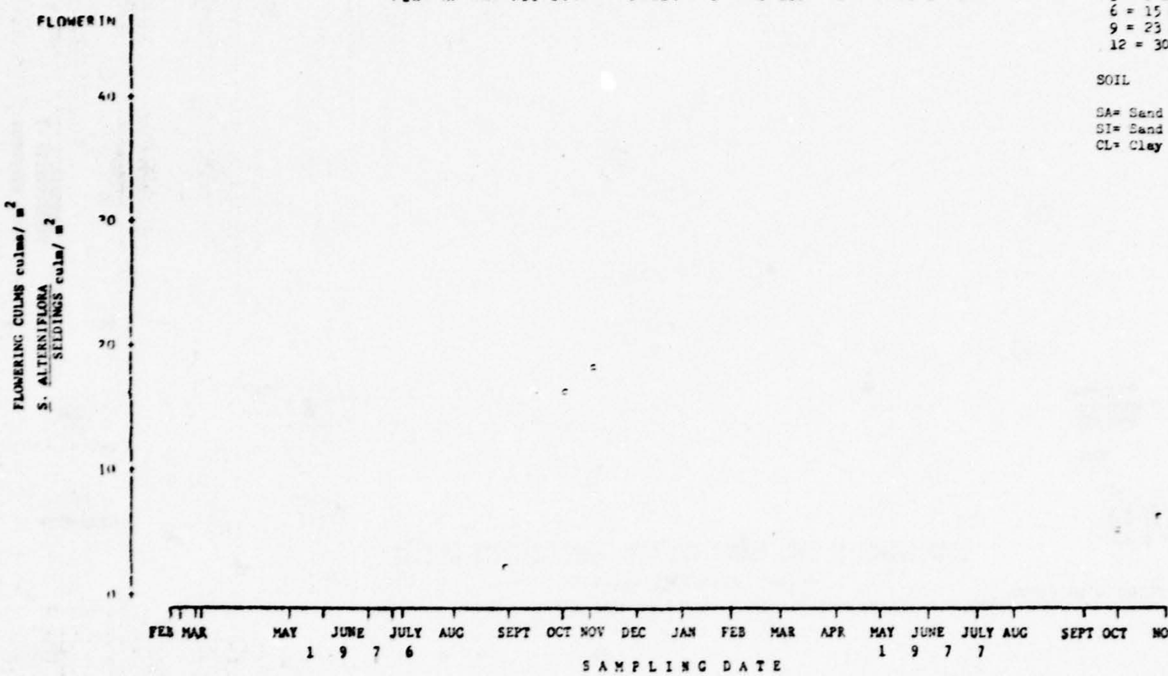
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

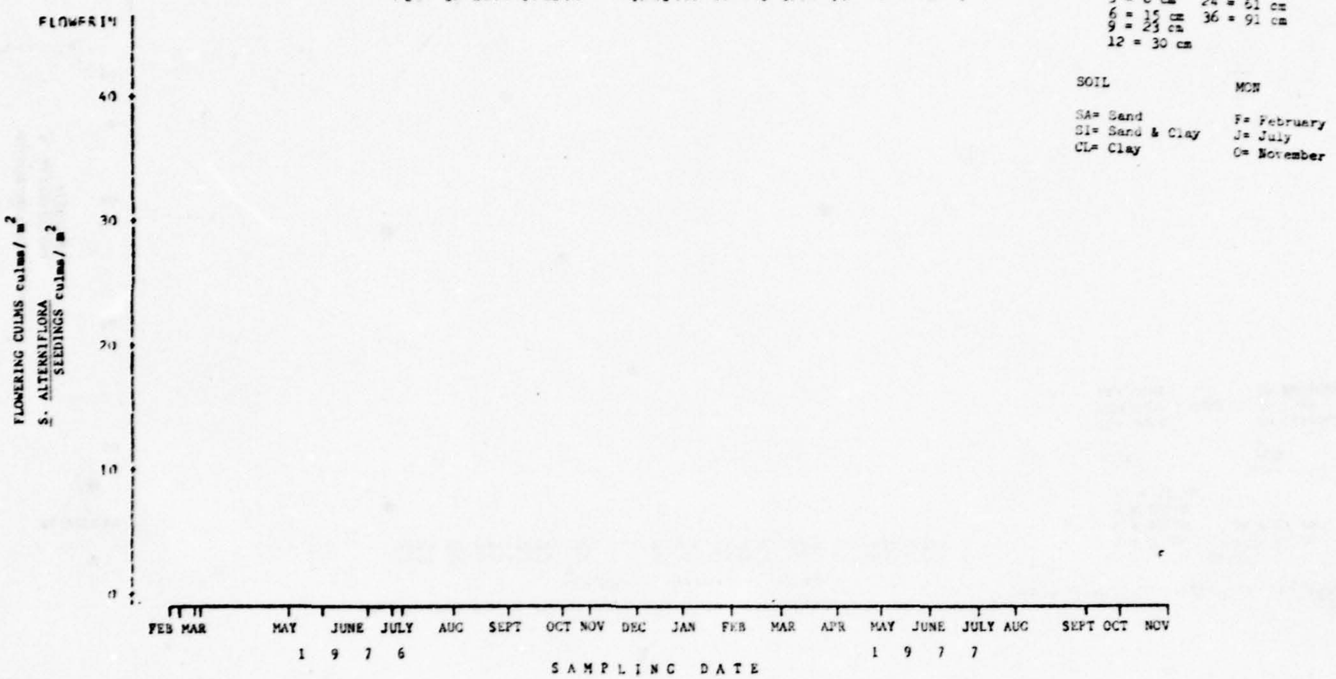
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 178
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=4 SOIL=SA MON=O

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

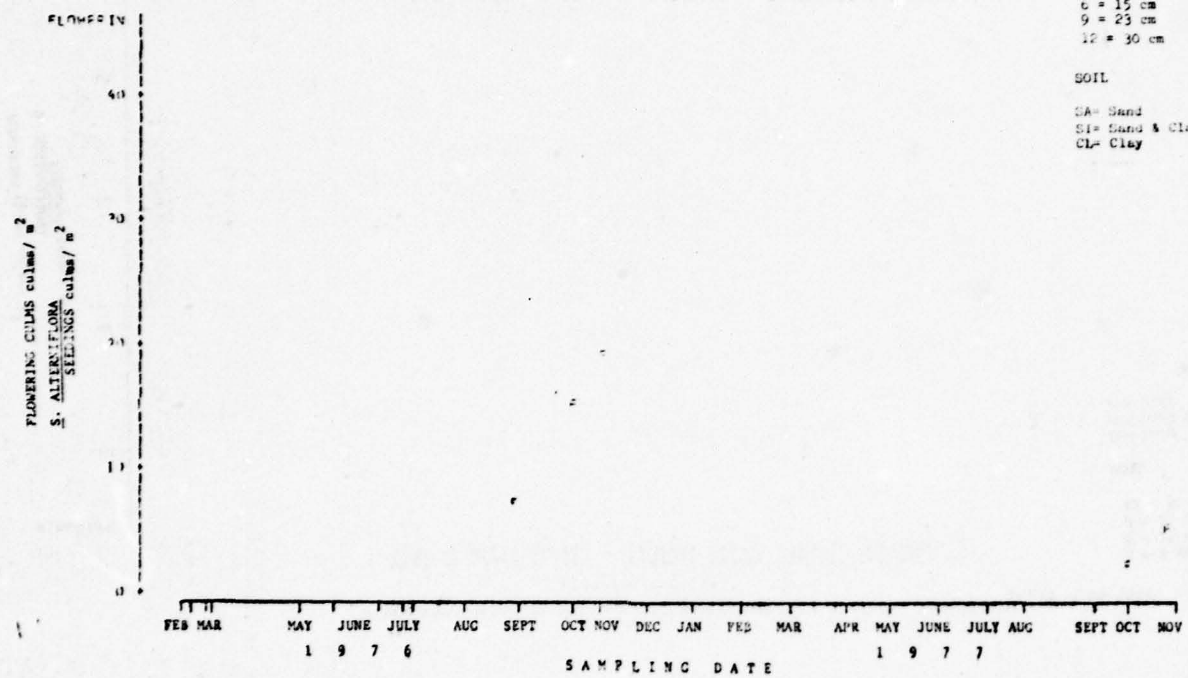


MARSH ENGINEERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 179

14:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT	
3 = 8 cm	24 = 61 cm
6 = 15 cm	36 = 91 cm
9 = 23 cm	
12 = 30 cm	

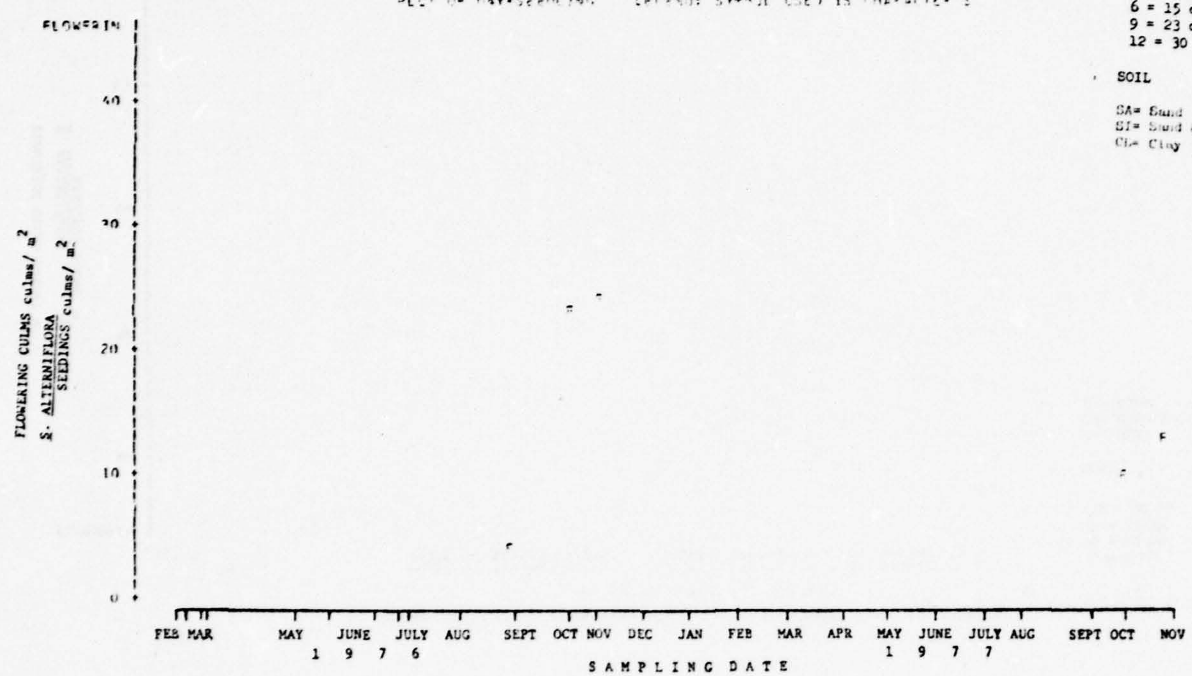
SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November



MARSH ENGINEERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 180
14:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=6 SOIL=SI MON=J

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

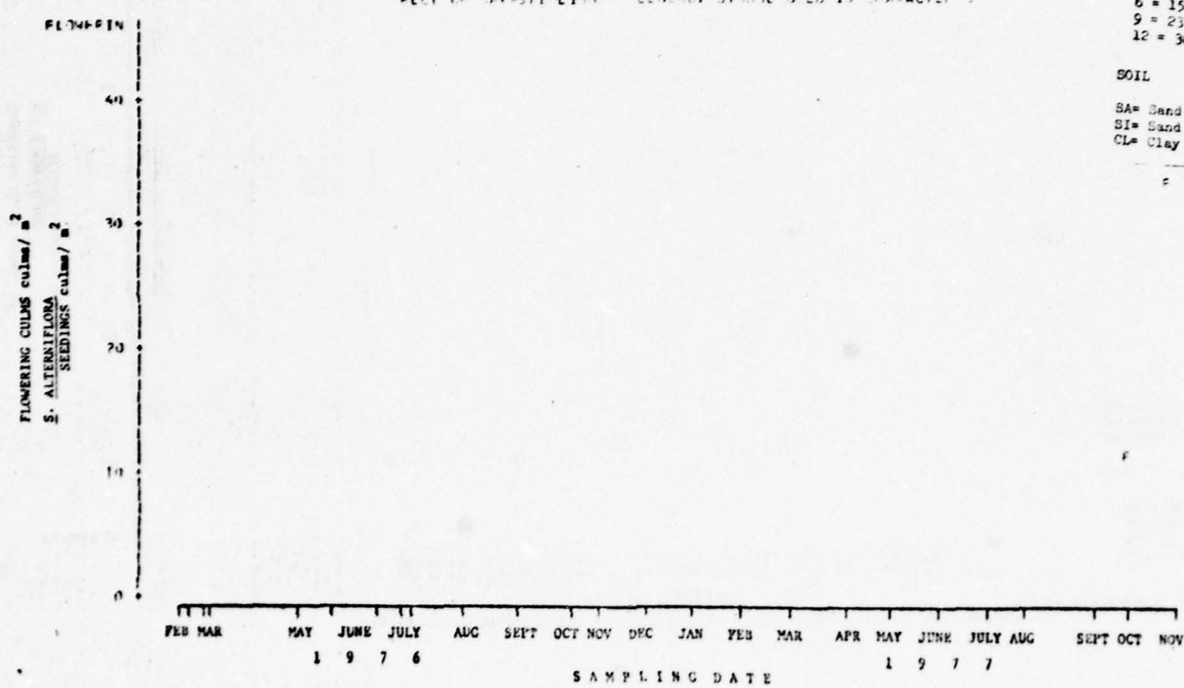
SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

HEIGHT=6 SOIL=SI MON=O

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



HEIGHT

3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

B201

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 182
16:23 WEDNESDAY, DECEMBER 21, 1977

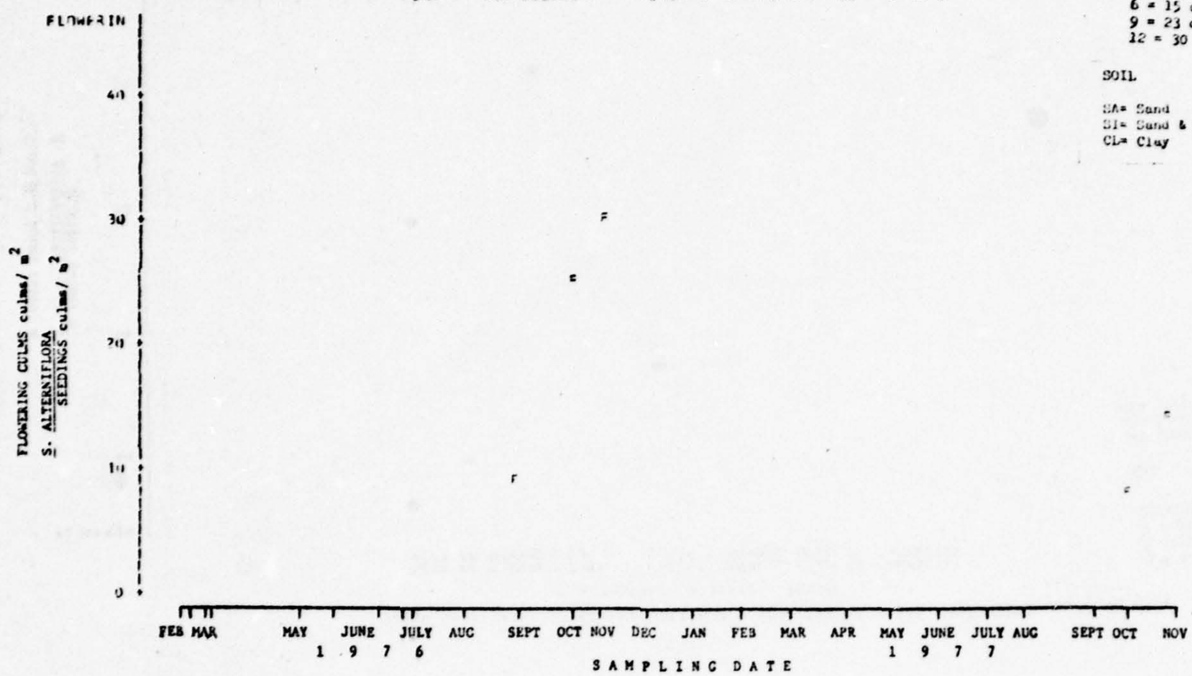
HEIGHT=9 SOIL=CL MON=F

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
30 = 91 cm

SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

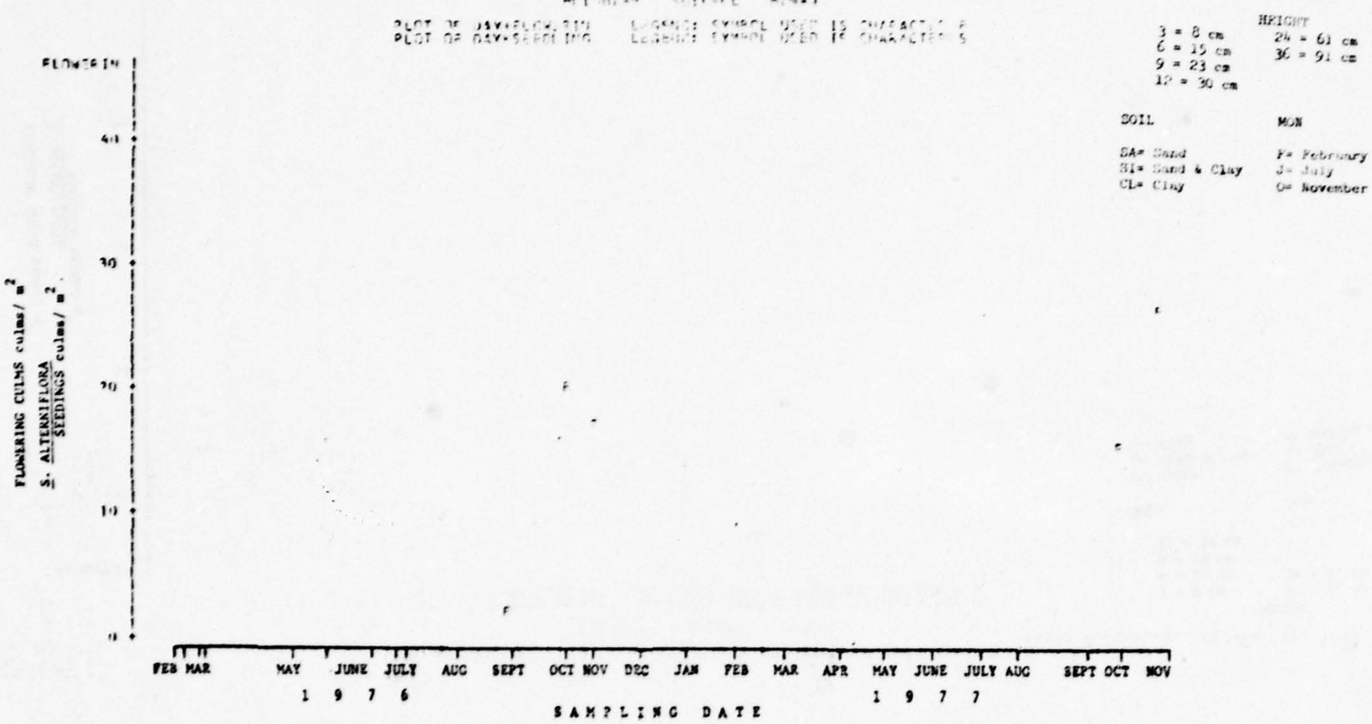
MON
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 183
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=9 SOIL=CL MON=J

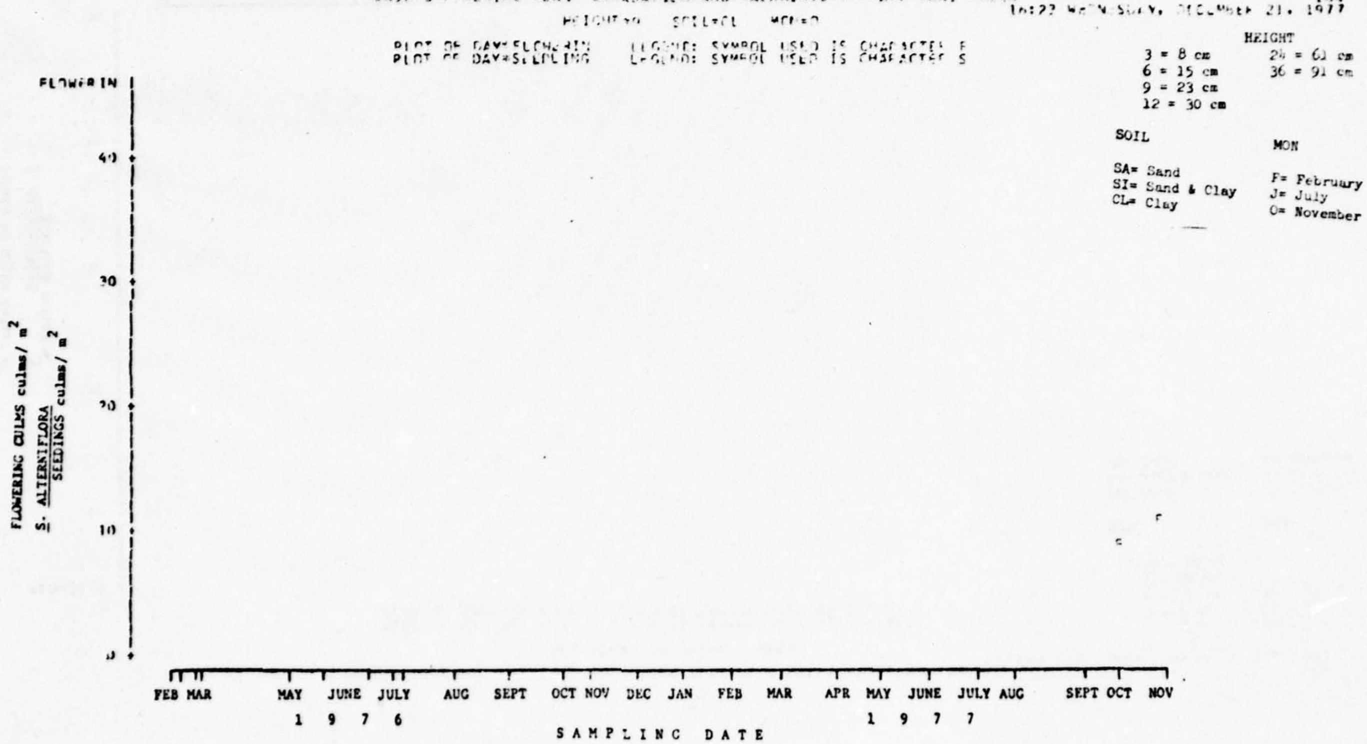
PLOT OF DAY*FLOWRIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:22 WEDNESDAY, DECEMBER 21, 1977 184

HEIGHT=9 SOIL=CL MON=O

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=9 SOIL=SI MON=F

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT

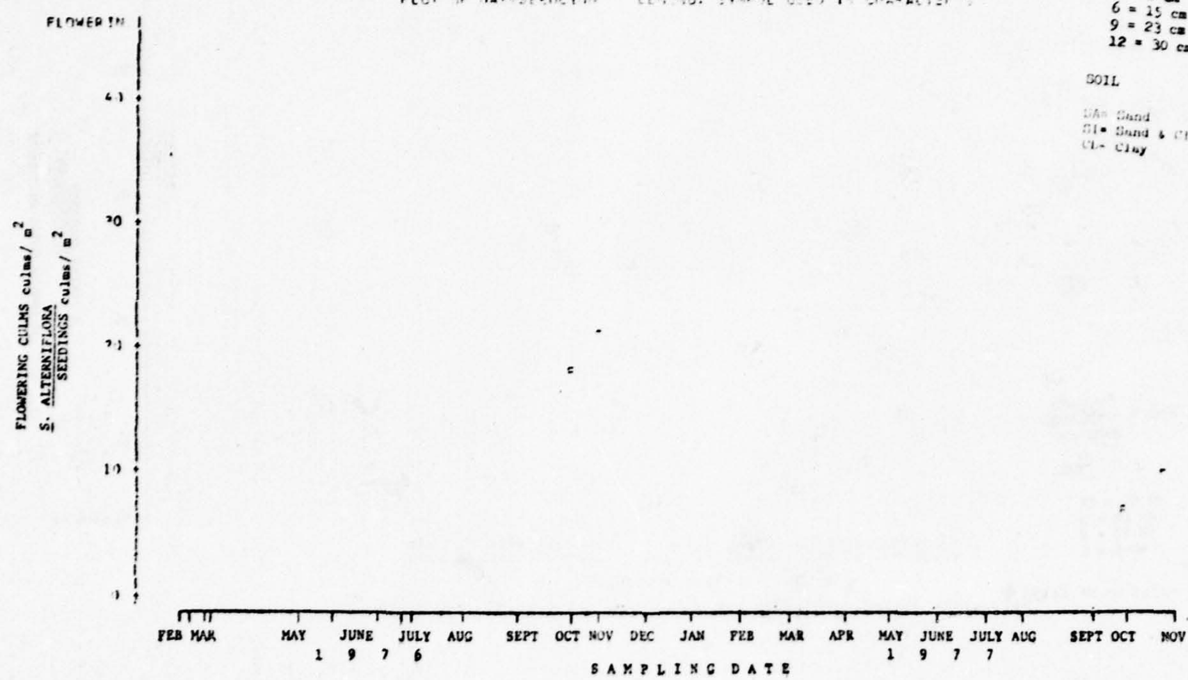
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

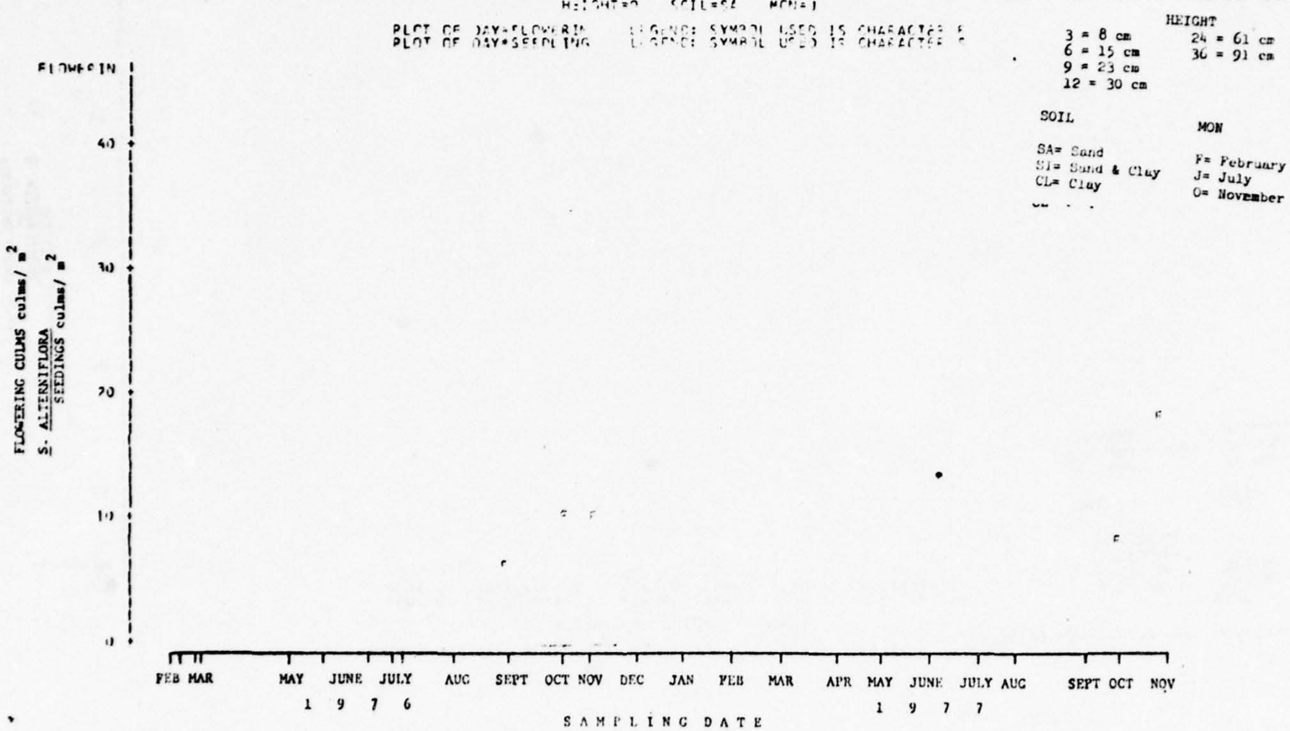


MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING

16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=0 SOIL=SA MON=J

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



B206

HEIGHT=9 SOIL=SA MON=O

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT

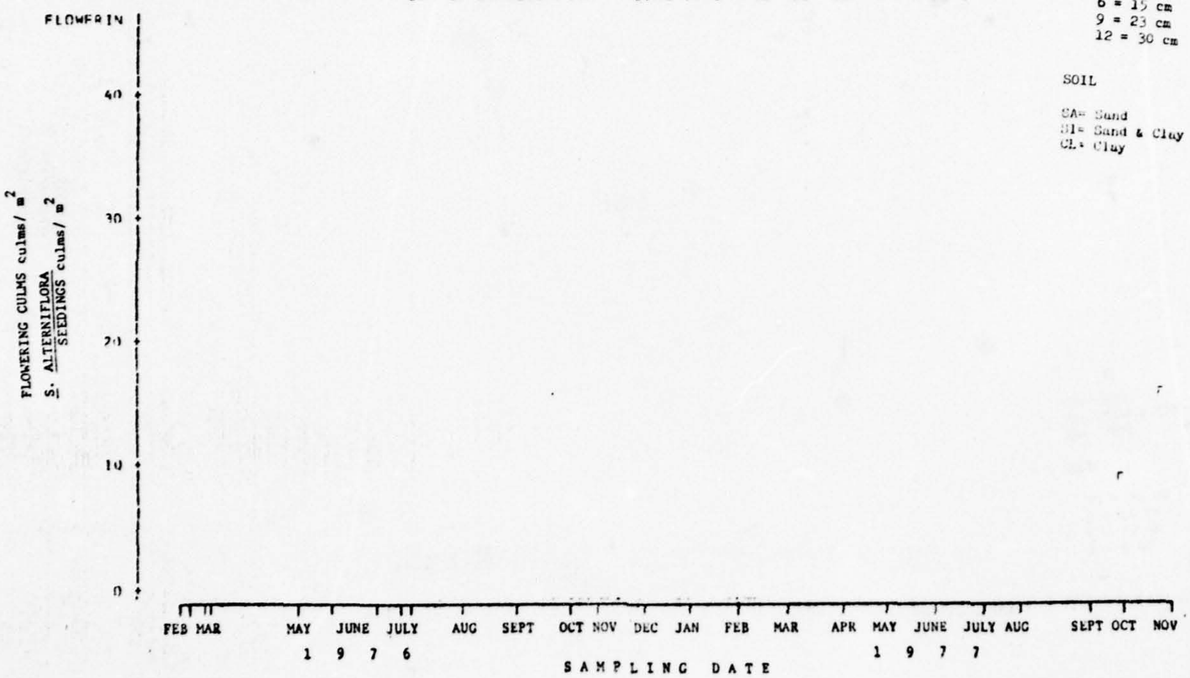
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

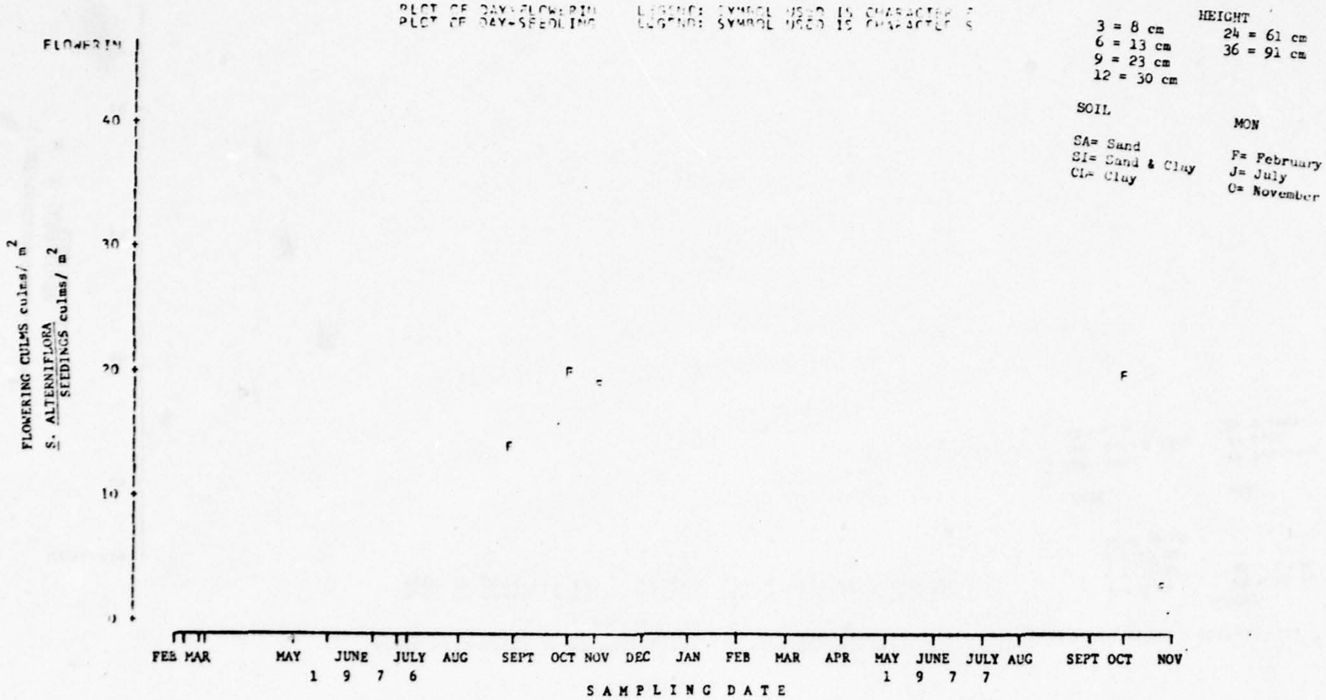
MON

F= February
J= July
O= November



HEIGHT=? SOIL=SI MON=F

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 189
16:23 WEDNESDAY, DECEMBER 21, 1977

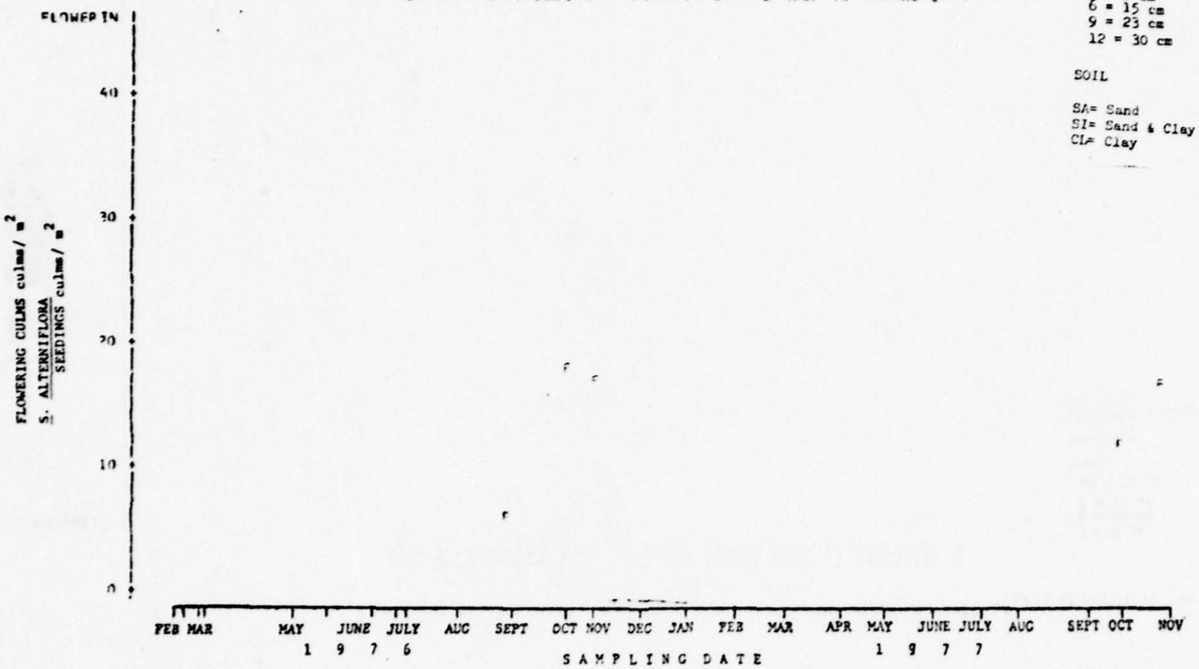
HEIGHT=9 SOIL=SI MON=J

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

MON
F= February
J= July
O= November



B209

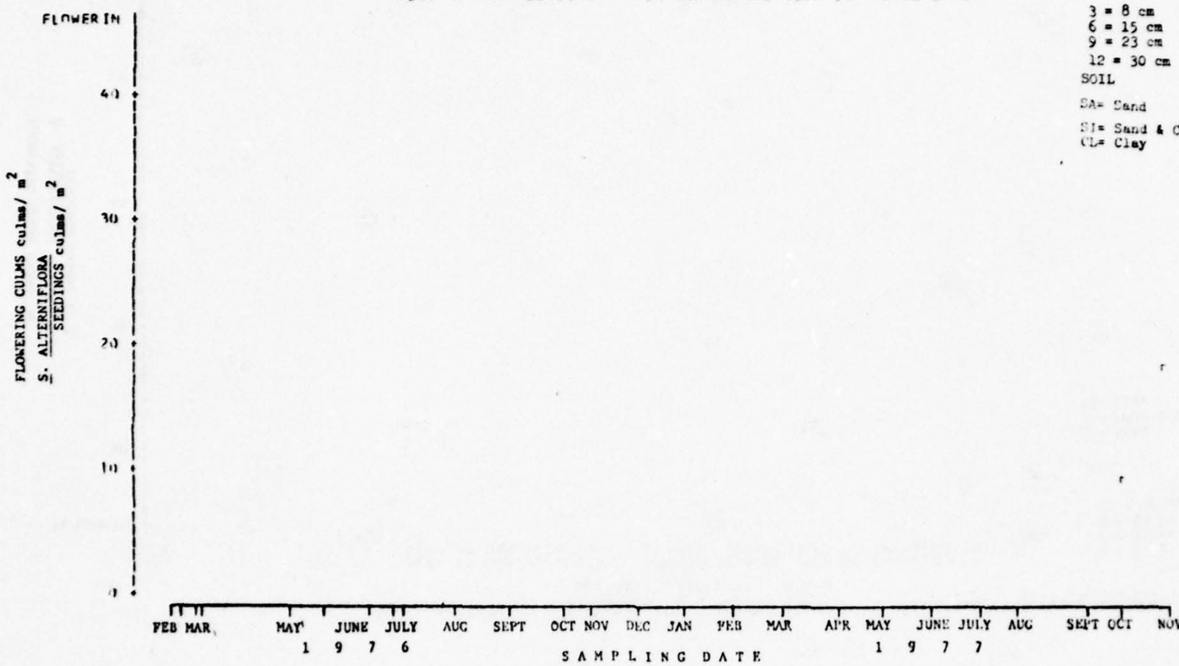
MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 190
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=9 SOIL=SI MON=J

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT	
3 = 8 cm	24 = 61 cm
6 = 15 cm	36 = 91 cm
9 = 23 cm	
12 = 30 cm	

SOIL	MON
SA= Sand	F= February
SI= Sand & Clay	J= July
CL= Clay	O= November

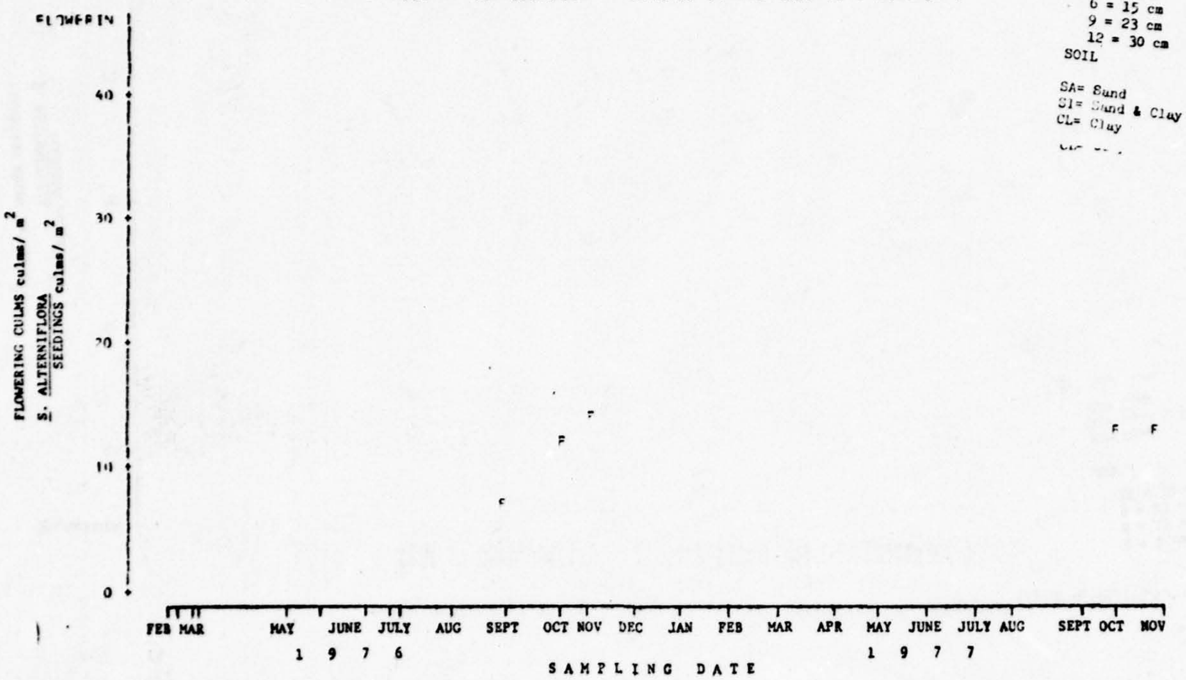


B210

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 191

HEIGHT=12 SOIL=CL MON=F

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

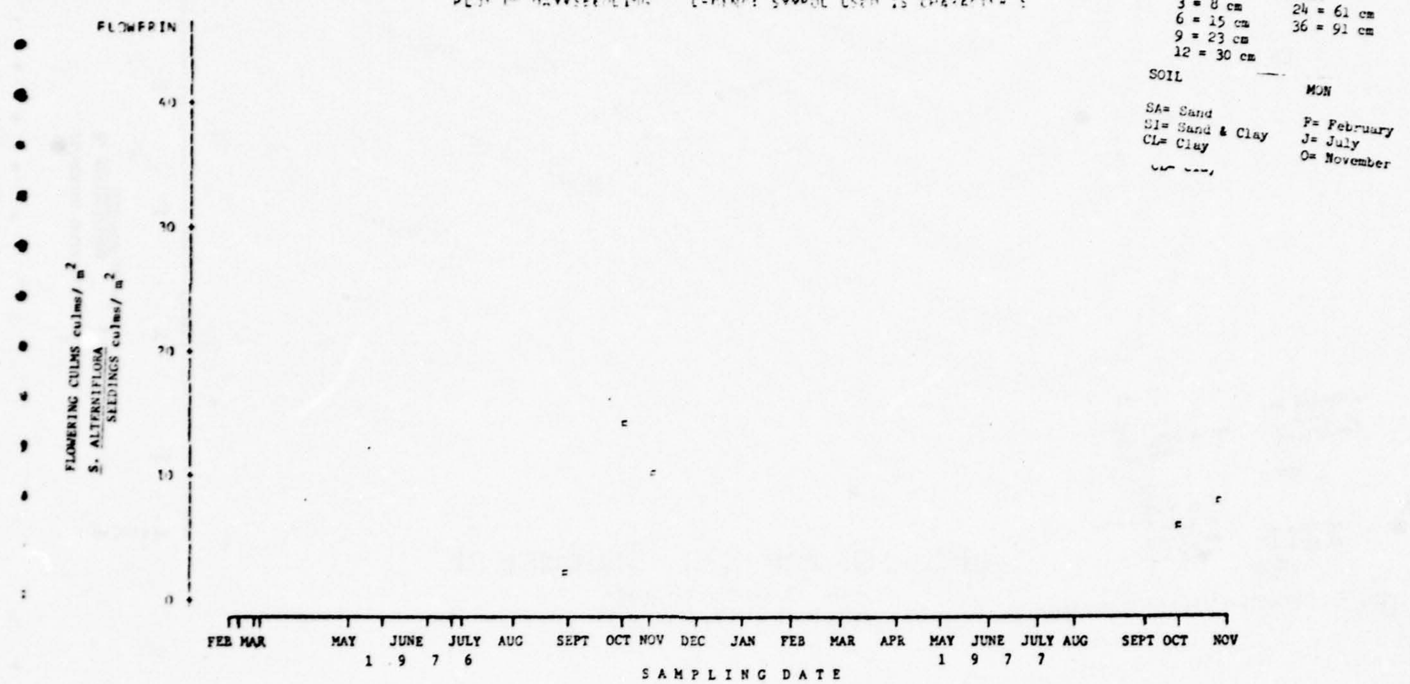
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

MON
F= February
J= July
O= November

B211

HEIGHT=12 SOIL=CL MON=J

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



B212

HEIGHT=12 SOIL=CL MON=O

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT

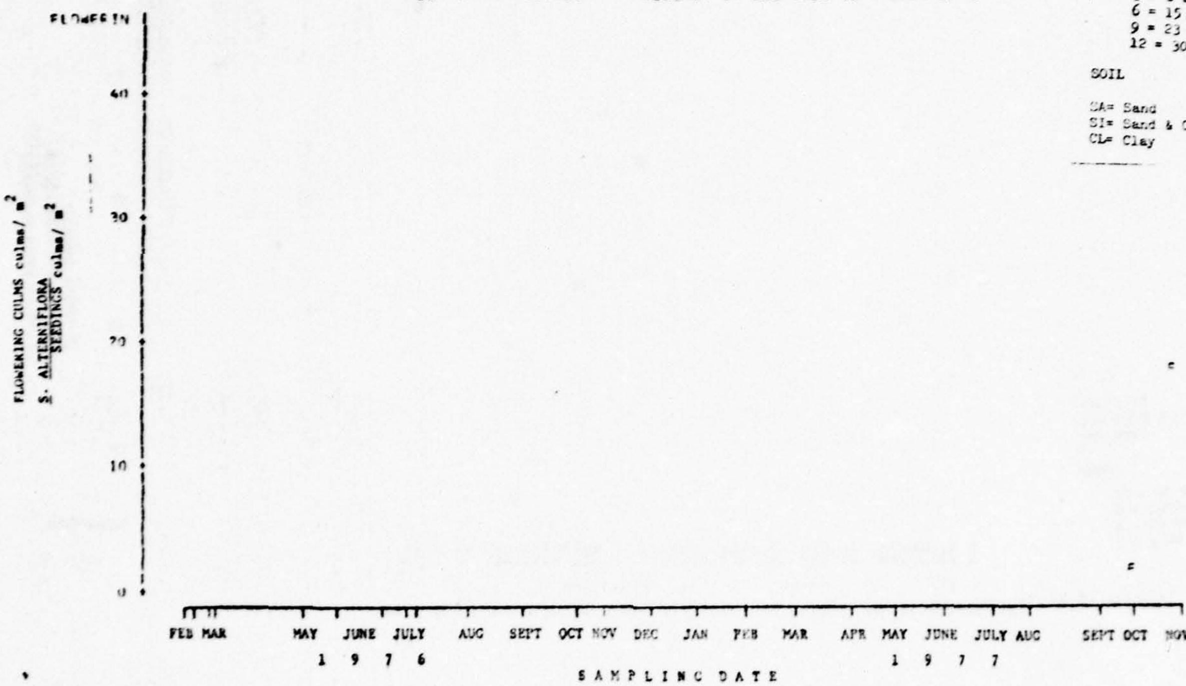
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November



B213

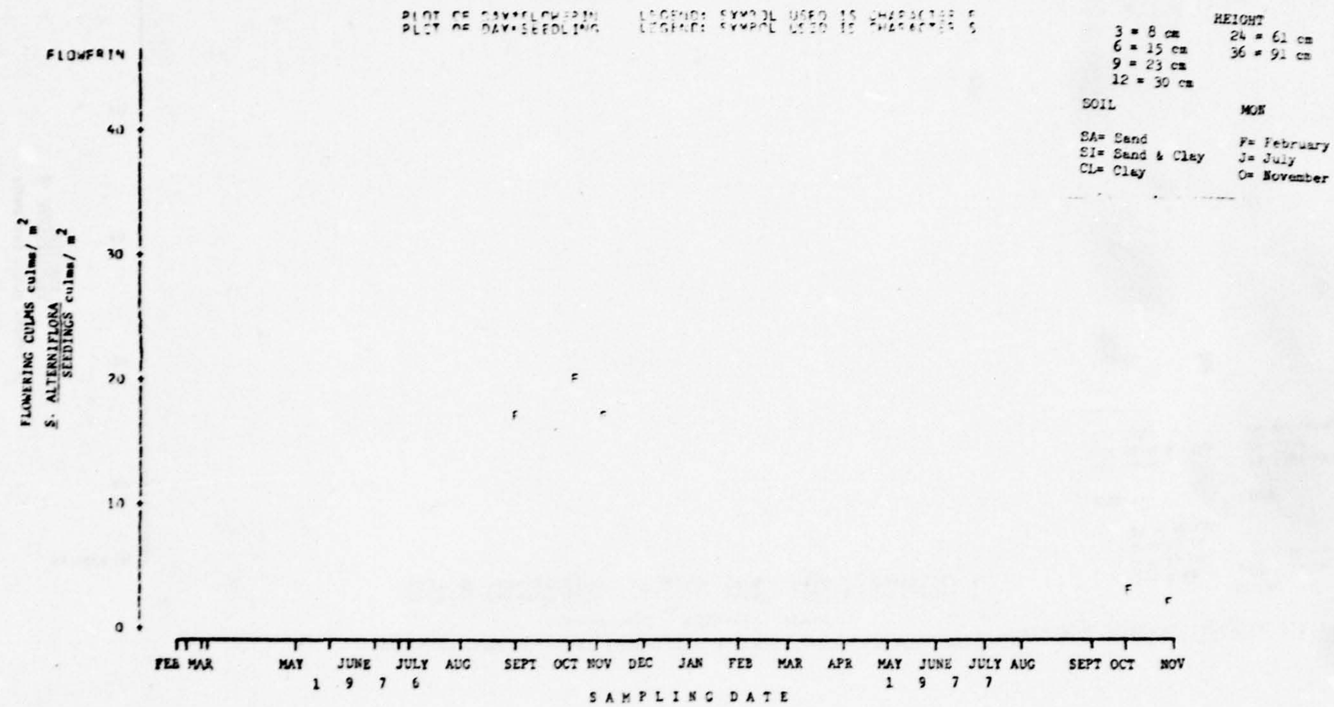
MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 194

14:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=12 SOIL=SA MON=F

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F

PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

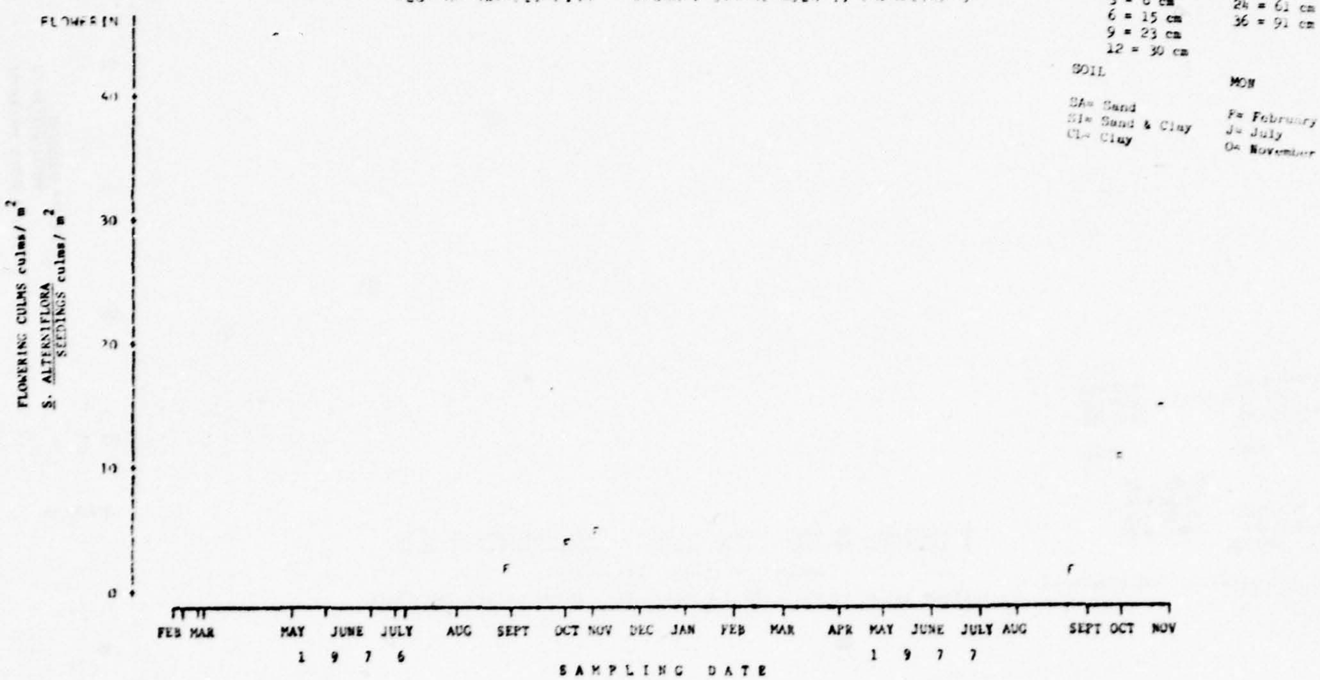


B214

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 195
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=12 SOIL=SA MON=J

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



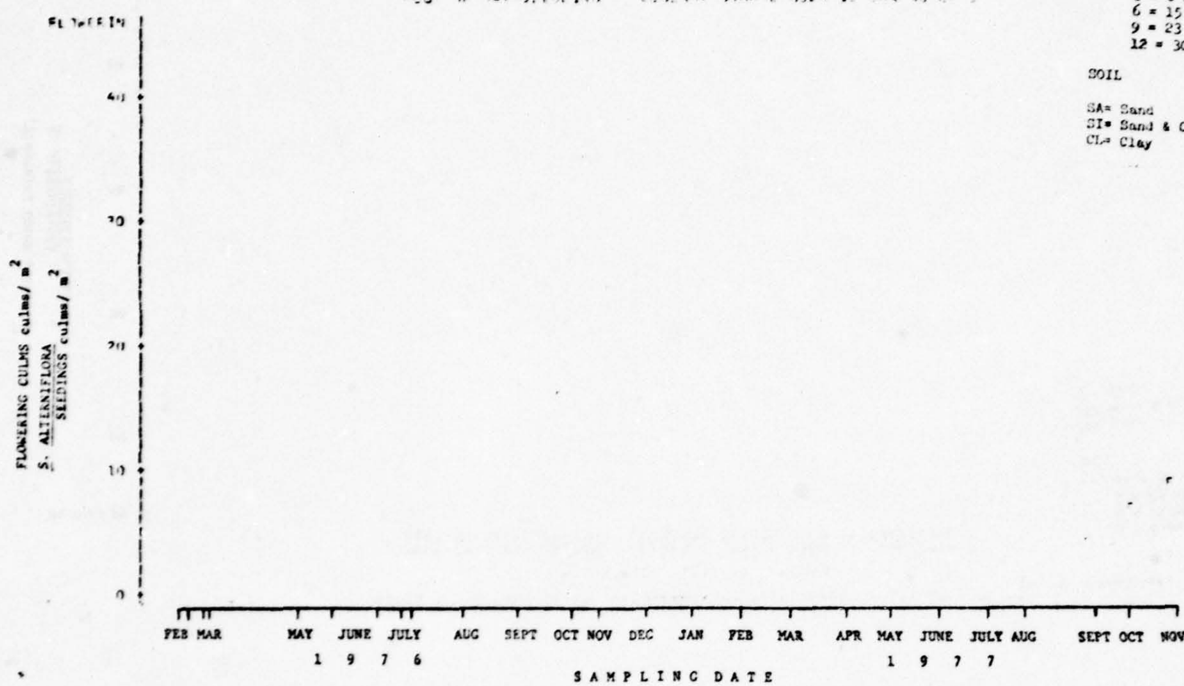
HEIGHT=12 SOIL=SA MON=O

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL
SA= Sand
SI= Sand & Clay
CL= Clay

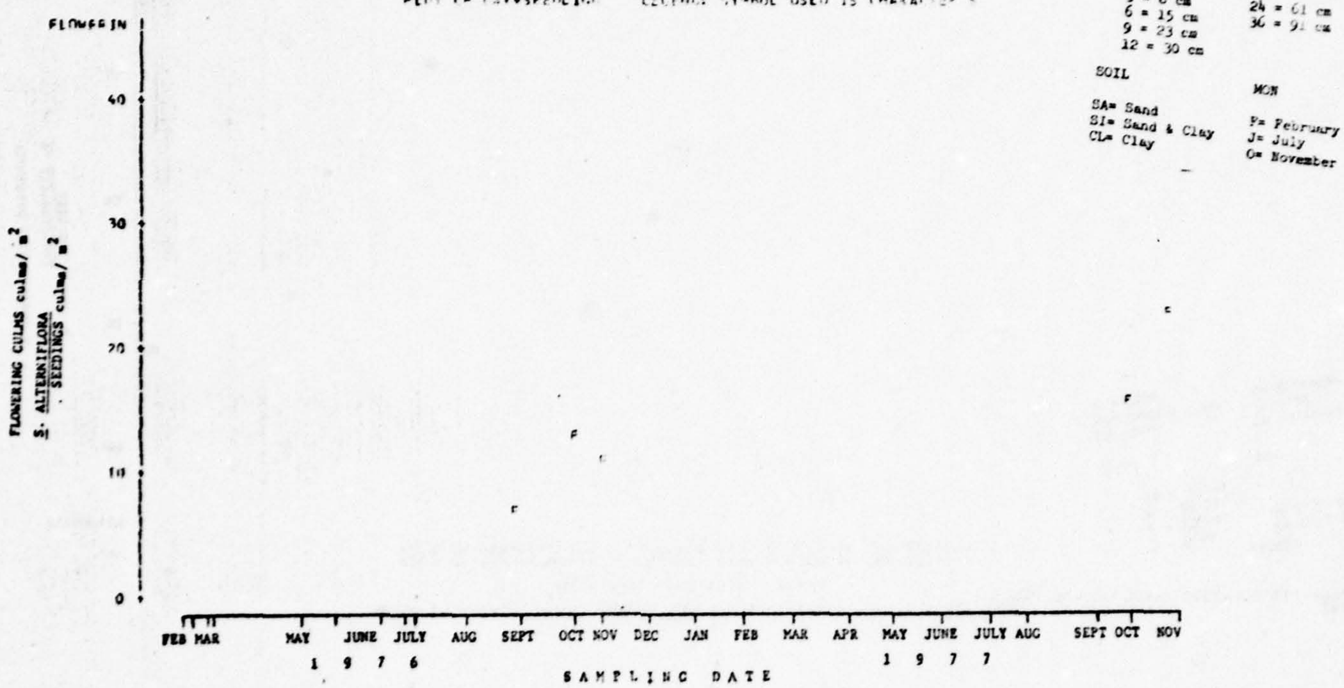
MON
F= February
J= July
O= November

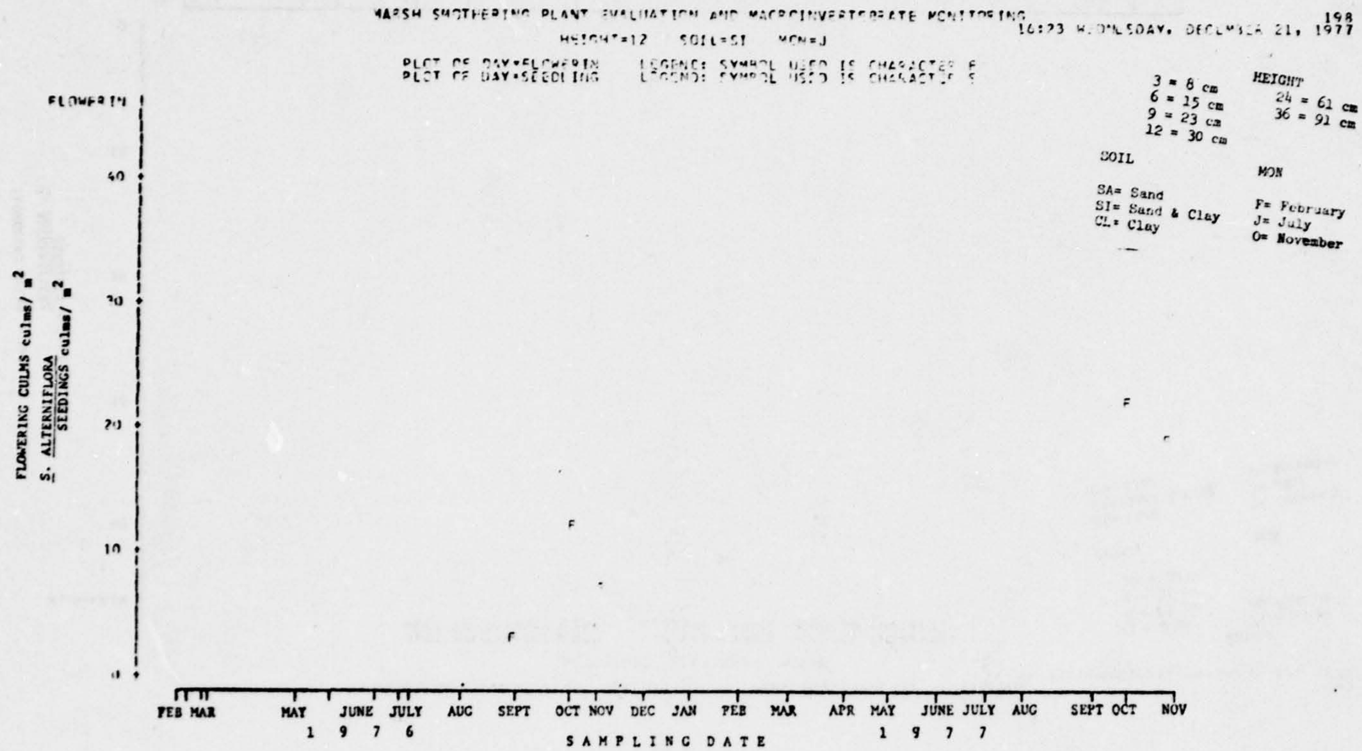


MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 197
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=12 SOIL=SI MON=F

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



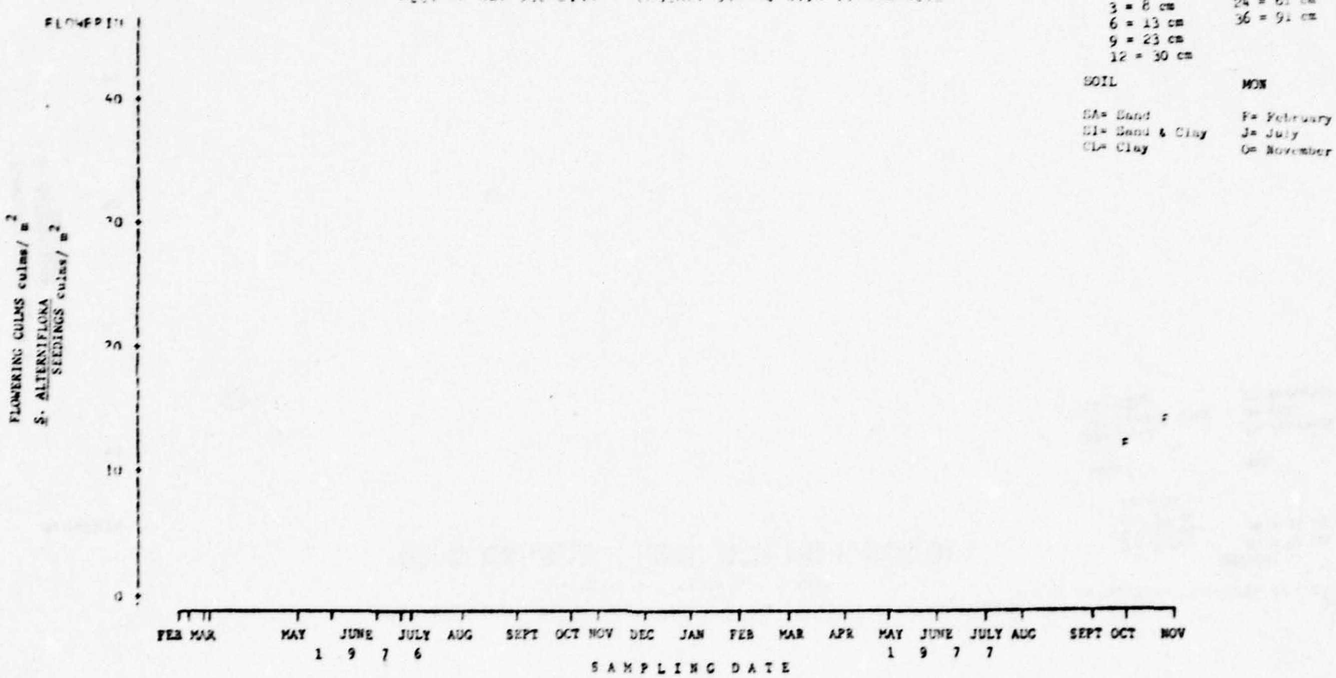

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING
198
16:23 WEDNESDAY, DECEMBER 21, 1977
HEIGHT=12 SOIL=SI MON=J
PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S
HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm
SOIL
SA= Sand
SI= Sand & Clay
CL= Clay
MON
F= February
J= July
O= November
FLOWERING CULMS culms/ m^2
S. ALTERNIFLORA
SEEDINGS culms/ m^2
FLOWERIN
40
30
20
10
0
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 199

16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=12 SOIL=SI MON=O

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

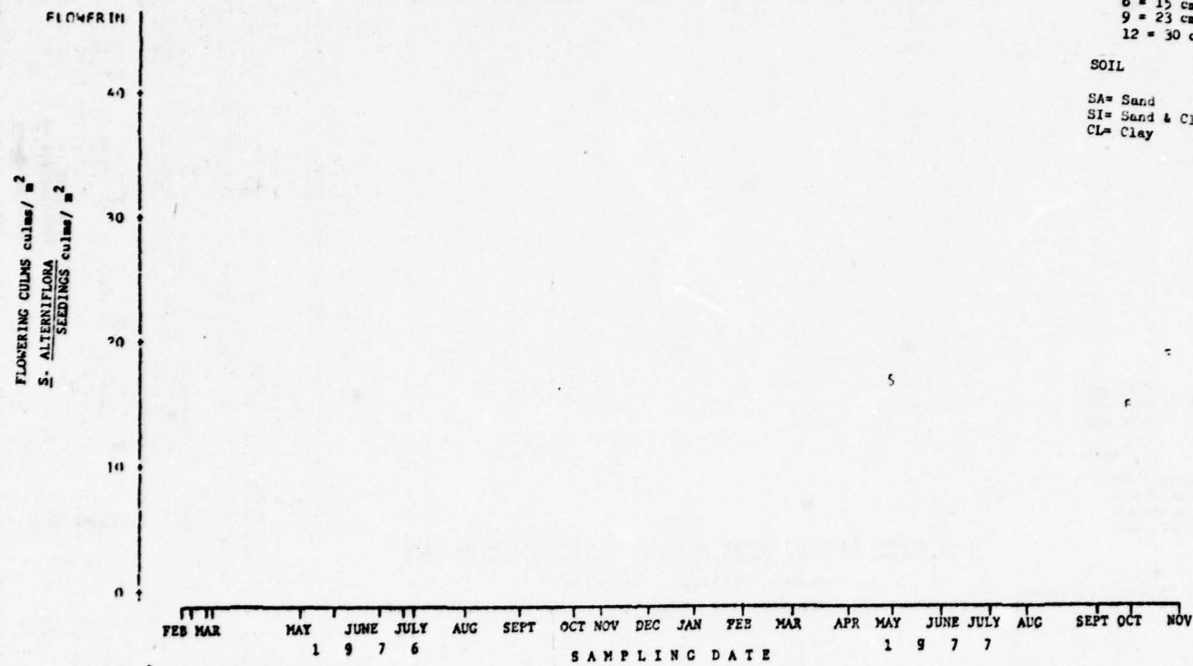


MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 200

16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=24 SOIL=CL MON=F

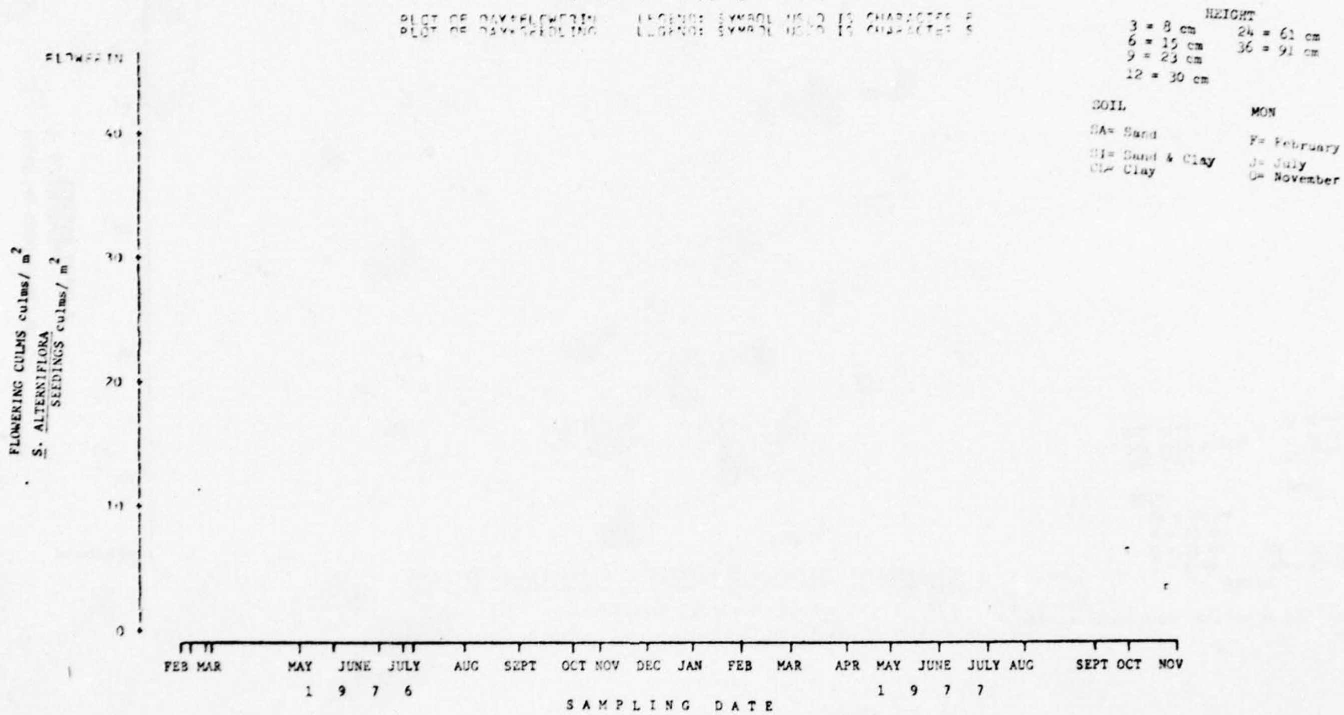
PLOT OF DAY=FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY=SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

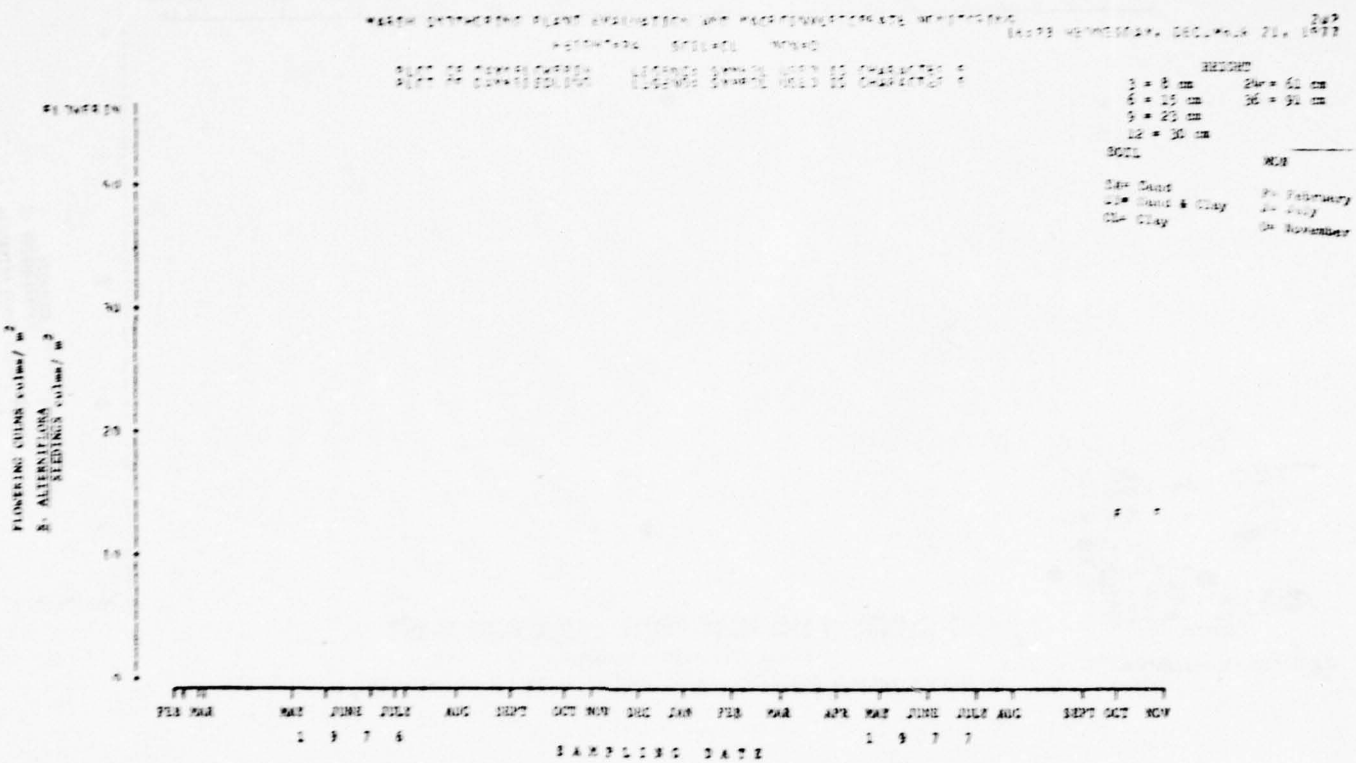


MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 14:23 WEDNESDAY, DECEMBER 21, 1977 201

HEIGHT=24 SOIL=CL MON=1

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S




FLOWERING CULMS culms/ m^2
B: ALTERNIFLORA
SEEDINGS culms/ m^2
HEIGHT
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm
SOIL
CL= Clay
MON
F= February
N= November
FEB MAR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1 9 7 6
1 9 7 7
SAMPLING DATE

HEIGHT=24 SOIL=SA MON=O

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT

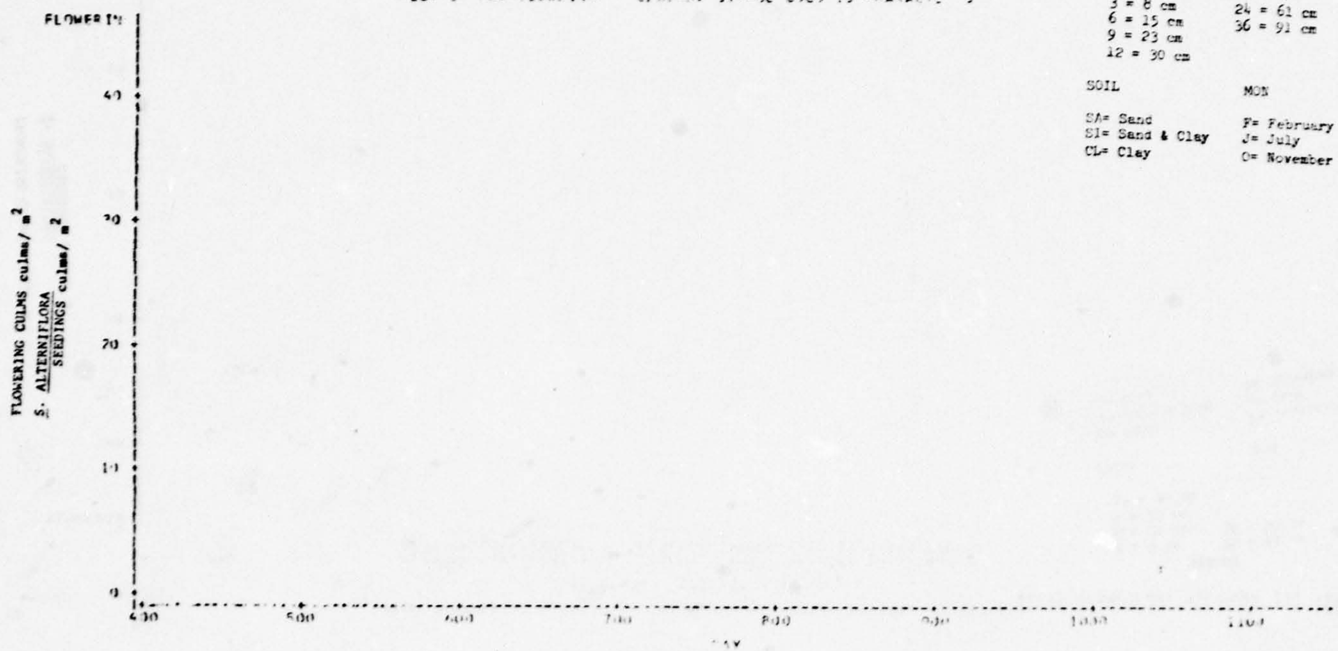
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

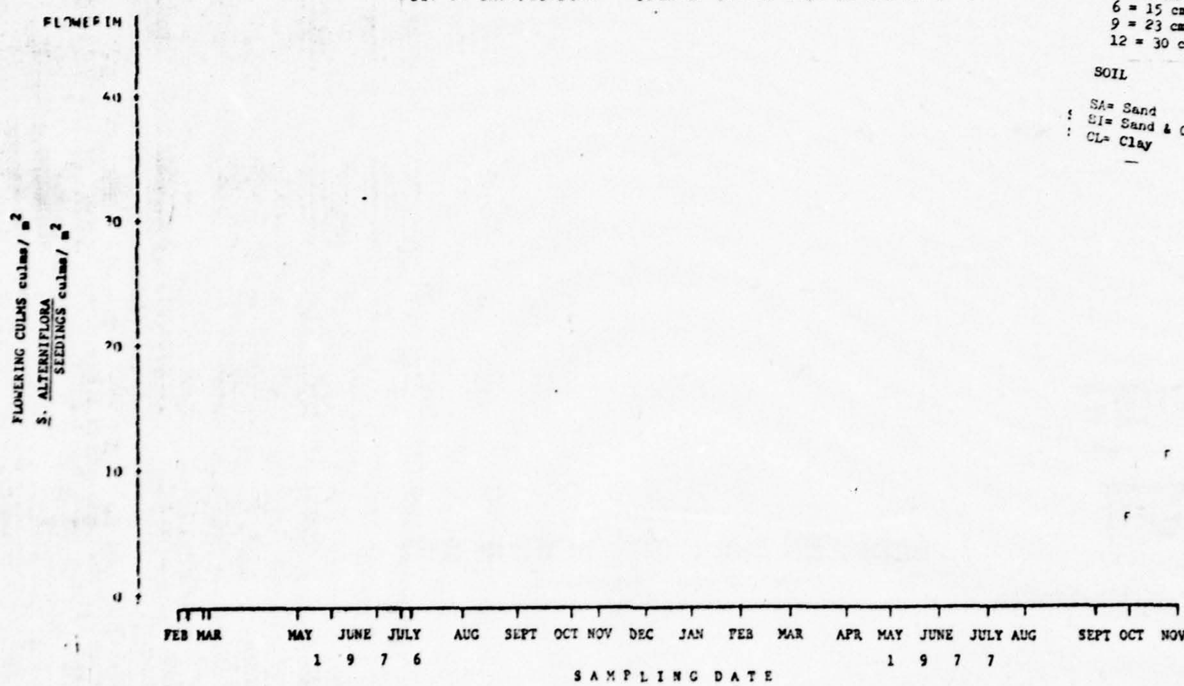
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 16:23 WEDNESDAY, DECEMBER 21, 1977 208

HEIGHT=24 SOIL=SI MON=O

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



HEIGHT

3 = 8 cm 24 = 61 cm
6 = 15 cm 36 = 91 cm
9 = 23 cm
12 = 30 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

F= February
J= July
O= November

B224

MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 209
16:23 WEDNESDAY, DECEMBER 21, 1977

HEIGHT=36 SOIL=CL MON=F

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S

HEIGHT

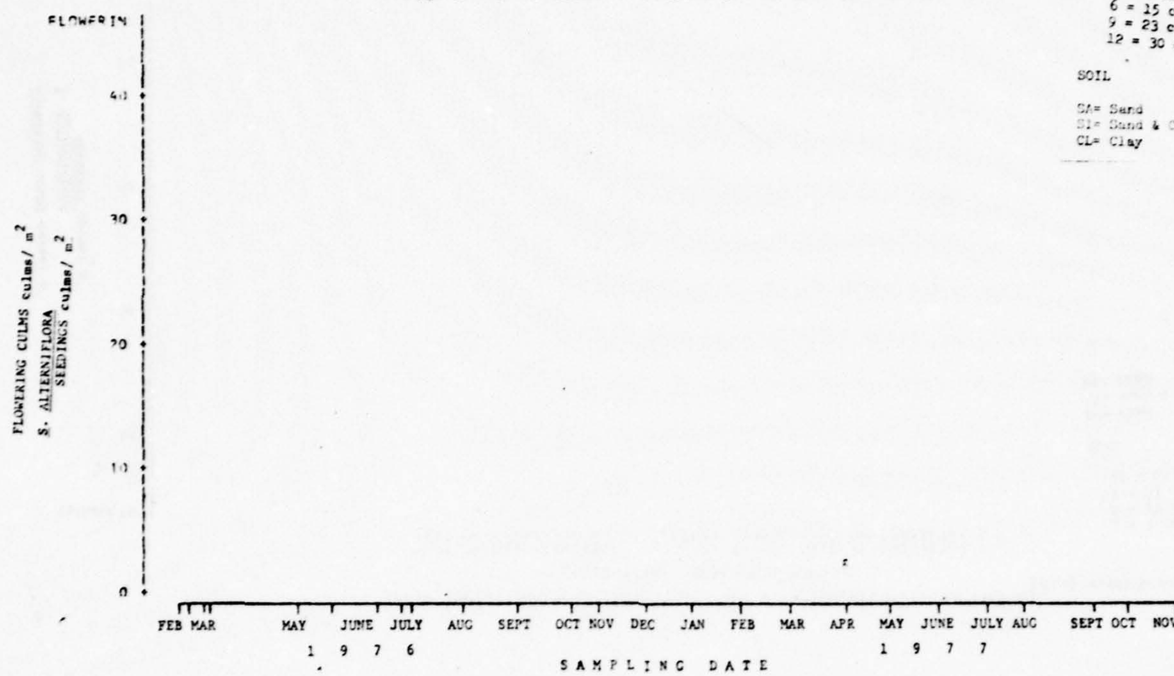
3 = 8 cm
6 = 15 cm
9 = 23 cm
12 = 30 cm
24 = 61 cm
36 = 91 cm

SOIL

SA= Sand
SI= Sand & Clay
CL= Clay

MON

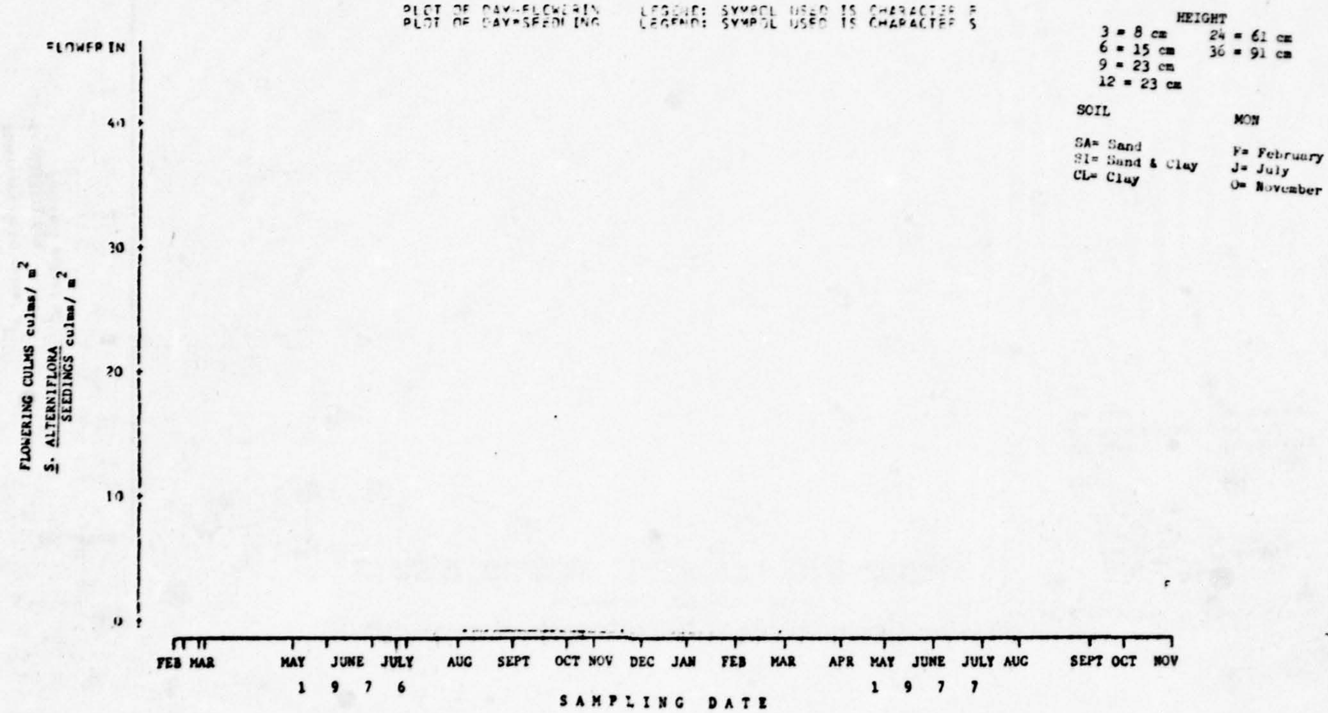
F= February
J= July
O= November



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING

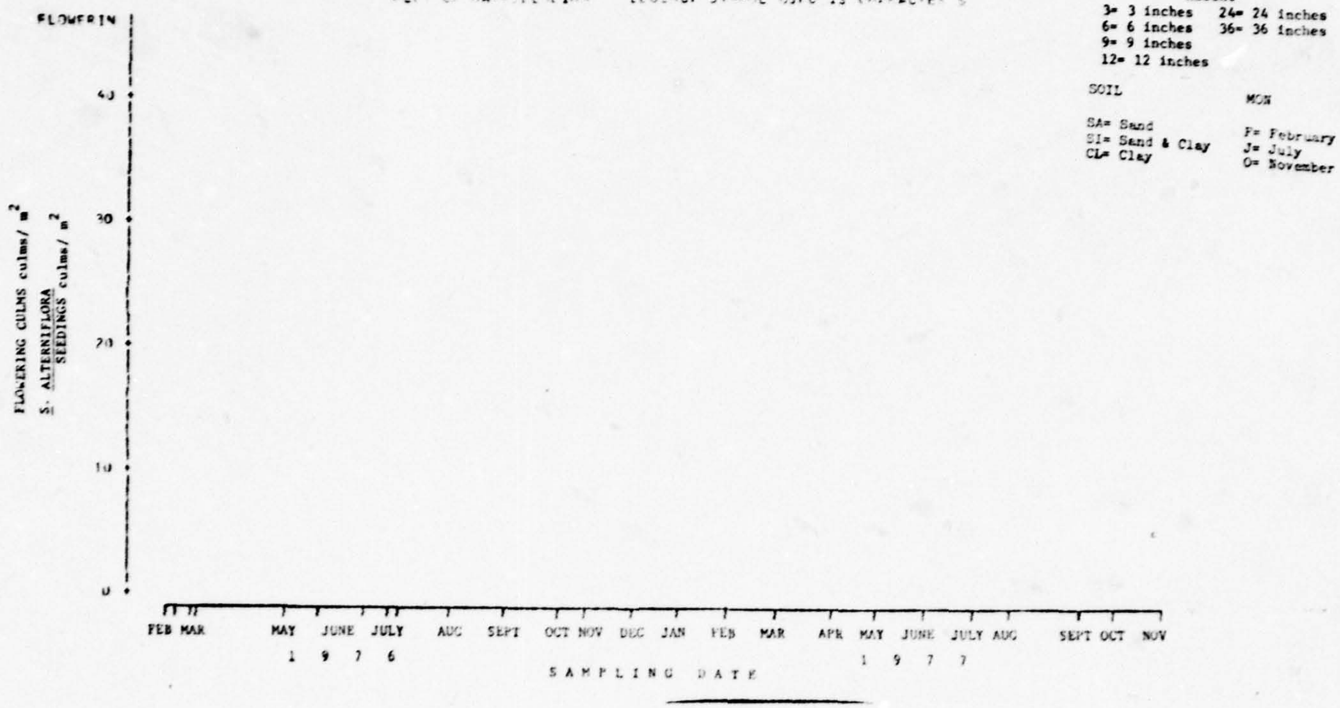
HEIGHT=36 SOIL=CL MON=J

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



MARSH SMOTHERING PLANT EVALUATION AND MACROINVERTEBRATE MONITORING 212
HEIGHT=36 SOIL=SA MON=F 14:23 WEDNESDAY, DECEMBER 21, 1977

PLOT OF DAY*FLOWERIN LEGEND: SYMBOL USED IS CHARACTER F
PLOT OF DAY*SEEDLING LEGEND: SYMBOL USED IS CHARACTER S



APPENDIX C

ANALYSIS OF VARIANCE FOR BIOMASS AND CULM DENSITY IN MARSH SMOTHERING ENCLOSURES

Legend for Dependent Variable Codes

Bhio	=	Dead material biomass gdw $/m^2$
L bio	=	Live material biomass gdw $/m^2$
Biomass	=	Combined Live and dead biomass gdw $/m^2$
L den	=	Live culms $/m^2$
D den	=	Dead culms $/m^2$

Legend for Class Variable Codes

Height	=	Enclosure height
3	=	8 cm
6	=	15 cm
9	=	23 cm
12	=	30 cm
24	=	61 cm
36	=	91 cm
Soil	=	Dredged Material type
SA	=	Sand
SI	=	Sand and Clay
CL	=	Clay
Mon	=	Month of Deposition
F	=	February 1976
J	=	July 1976
O	=	November 1976

Control

0 = Experimental Enclosures (0.656 m^2)

1 = Control Enclosures (0.656 m^2)

PART 1

Analysis of Variance

General Linear Model

April and November 1977 data.

PART 1

STATISTICAL ANALYSIS SYSTEM 12:08 THURSDAY, APRIL 20, 1976 1

GENERAL LINEAR MODELS PROCEDURE

CLASS LEVEL INFORMATION

CLASS	LEVELS	VALUES
HEIGHT	6	3 6 9 12 24 36
SOIL	3	CL SA SI
MON	3	F J O
CONT	2	0 1

NUMBER OF OBSERVATIONS IN DATA SET = 218

GROUP	OBS	DEPENDENT VARIABLES
1	218	DBIO LBIO BIOMASS
2	215	LDEN
3	170	DDEN

NOTE: VARIABLES IN EACH GROUP ARE CONSISTENT WITH RESPECT TO THE PRESENCE OR ABSENCE OF MISSING VALUES.

C4

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: DBIO

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	53	3102758.53792807	58542.61392317	1.92	0.0010	0.383318	98.5629
ERROR	164	4991712.04456000	30437.26856439		STD DEV		DBIO MEAN
CORRECTED TOTAL	217	8094470.58248807			174.46279994		177.00620550

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	344715.18430398	2.27	0.0499	5*	239942.97588863	1.58	0.1683
SOIL	2	21168.90320710	0.35	0.7068	2*	29115.55002564	0.48	0.6207
HEIGHT*SOIL	10	186485.58794744	0.61	0.8016	10*	254019.71065216	0.83	0.5960
MON	2	427617.30105612	7.02	0.0012	2*	490974.65445276	8.07	0.0005
HEIGHT*MON	7	245566.70769078	1.15	0.3329	6*	70828.61925912	0.39	0.8861
SOIL*MON	4	99731.20871574	0.82	0.5147	4*	95060.68985599	0.78	0.5392
HEIGHT*SOIL*MON	12	195709.92615357	0.54	0.8890	12	249879.70445540	0.68	0.7651
CONT	1	1129655.96589798	37.11	0.0001	1*	1157422.33786800	38.03	0.0001
HEIGHT*CONT	3	129253.57852010	1.42	0.2390	3*	136783.34876993	1.50	0.2157
SOIL*CONT	2	64051.46665120	1.05	0.3515	2*	52826.55229415	0.87	0.4218
HEIGHT*SOIL*CONT	5	258802.80778405	1.70	0.1361	5	258802.80778405	1.70	0.1361
MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
HEIGHT*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
SOIL*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
HEIGHT*SOIL*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.

* NOTE: OTHER TYPE IV TESTABLE HYPOTHESES EXIST WHICH MAY YIELD DIFFERENT SS.

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LBIO

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	53	8384014.04175684	158188.94418409	2.40	0.0001	0.436505	47.4122
ERROR	154	10823108.84693364	65994.56612966		STD DEV		LBIO MEAN
CORRECTED TOTAL	217	19207122.88869043			256.89407572		541.83119266

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	2831623.69417799	8.58	0.0001	5*	792987.65982613	2.40	0.0388
SOIL	2	764776.56423331	5.79	0.0037	2*	873273.33050144	6.62	0.0017
HEIGHT*SOIL	10	985295.43862384	1.49	0.1460	10*	587920.87483856	0.89	0.5431
MON	2	132873.27661279	1.01	0.3677	2*	309918.00886574	2.35	0.0988
HEIGHT*MON	7	117828.39838701	0.26	0.9688	6*	239768.86618040	0.61	0.7257
SOIL*MON	4	49765.74008034	0.19	0.9441	4*	192740.51208540	0.73	0.5726
HEIGHT*SOIL*MON	12	501860.22329475	0.63	0.8113	12	654896.58658021	0.83	0.6225
CONT	1	1467678.37038629	22.24	0.0001	1*	1452012.16684845	22.00	0.0001
HEIGHT*CONT	3	697705.64864787	3.52	0.0163	3*	435798.29588772	2.20	0.0885
SOIL*CONT	2	403861.37126705	3.06	0.0496	2*	354135.26958556	2.68	0.0714
HEIGHT*SOIL*CONT	5	430545.31604560	1.30	0.2636	5	430545.31604560	1.30	0.2636
MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
HEIGHT*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
SOIL*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
HEIGHT*SOIL*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.

* NOTE: OTHER TYPE IV TESTABLE HYPOTHESES EXIST WHICH MAY YIELD DIFFERENT SS.

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: BIOMASS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	53	14494245.11342378	273476.32289479	2.23	0.0001	0.418438	48.7559
ERROR	164	20144680.09512055	122833.41521415		STD DEV		BIOMASS MEAN
CORRECTED TOTAL	217	34638925.20854434			350.47598379		718.83779817

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	2492039.55335276	4.06	0.0018	5*	1051989.72393871	1.71	0.1332
SOIL	2	871109.43095383	3.55	0.0311	2*	1167725.00857262	4.75	0.0098
HEIGHT*SOIL	10	1468544.78534899	1.20	0.2974	10*	767031.74483897	0.62	0.7915
MON	2	1036588.67788978	4.22	0.0163	2*	1522255.59723057	6.20	0.0025
HEIGHT*MON	7	208269.88718526	0.24	0.9729	6*	187013.51383016	0.25	0.9572
SOIL*MON	4	226682.84800504	0.46	0.7640	4*	348182.61454309	0.71	0.5871
HEIGHT*SOIL*MON	12	837886.10436723	0.57	0.8651	12	1055830.44100160	0.72	0.7341
CONT	1	5172579.27774262	42.11	0.0001	1*	5202186.95473315	42.35	0.0001
HEIGHT*CONT	3	1078047.02551886	2.93	0.0350	3*	767958.07888900	2.08	0.1028
SOIL*CONT	2	595429.41488064	2.42	0.0918	2*	483369.78870736	1.97	0.1431
HEIGHT*SOIL*CONT	5	507068.10817881	0.83	0.5349	5	507068.10817881	0.83	0.5349
MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
HEIGHT*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
SOIL*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
HEIGHT*SOIL*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.

* NOTE: OTHER TYPE IV TESTABLE HYPOTHESES EXIST WHICH MAY YIELD DIFFERENT SS.

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   12:08 THURSDAY, APRIL 2[illegible], 1978   5

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE DHIO

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=164   MS=30437.3

GROUPING		MEAN	N	HEIGHT
	A	310.874286	7	36
B	A	295.060000	6	24
B	A	199.943846	52	12
B	A	184.185660	53	9
B		149.255200	50	3
B		140.385600	50	6

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LRIO

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=164   MS=65994.6

GROUPING	MEAN	N	HEIGHT
A	904.906667	6	24
B	625.115200	50	3
B			
B	616.086400	50	6
B			
B	523.482264	53	9
C	390.143077	52	12
C			
C	371.097143	7	36

```
S T A T I S T I C A L   A N A L Y S I S   S Y S T E M     12:08 THURSDAY, APRIL 20, 1978    7
                  GENERAL LINEAR MODELS PROCEDURE
           DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE BIOMASS

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

     ALPHA LEVEL=.05       DF=164       MS=122933

     GROUPING                 MEAN      N     HEIGHT

            A          1199.966667      6     24

            B           774.370400     50     3
            B
            B           756.472000     50     6
            B
     C      B           707.667925     53     9
     C      B
     C      B           681.971429      7     36
     C
     C                  590.086923     52     12
```

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE DH10

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=164   MS=30437.3

GROUPING	MEAN	N	SOIL
A	186.816316	76	SA
A			
A	184.191304	69	CL
A			
A	160.002740	73	SI

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LBIO

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=164   MS=65994.6

GROUPING	MEAN	N	SOIL
A	624.125217	69	CL
B	514.218082	73	SI
B			
B	493.640000	76	SA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE BIOMASS

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=164   MS=122833

GROUPING	MEAN	N	SOIL
A	808.316522	69	CL
B	680.456316	76	SA
B			
B	674.220822	73	SI

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE DBIO

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=164   MS=30437.3

GROUPING	MEAN	N	MON
A	214.433000	80	O
A			
A	205.720563	71	F
B	101.890149	67	J

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   12:08 THURSDAY, APRIL 20, 1978   14

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LHIO

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=164   MS=65994.6

GROUPING	MEAN	N	MON
A	564.262000	80	O
A			
A	555.206761	71	F
A			
A	500.874030	67	J

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   12:5[illegible] THURSDAY, APRIL 20, 1978   13

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE BIOMASS

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=164   MS=122833

GROUPING	MEAN	N	MON
A	778.695000	80	O
A			
A	760.927324	71	F
B	602.764179	67	J

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   12:0[illegible] THURSDAY, APRIL 20, 1978   14

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE DRIO

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=164   MS=39437.3

GROUPING	MEAN	N	CONT
A	355.530000	36	0
B	142.089890	182	1

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   12:0[illegible] THURSDAY, APRIL 20, 1976   15

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LBIO

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=164   MS=65994.6

GROUPING	MEAN	N	CONT
A	714.400000	36	0
B	507.696703	182	1

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   12:08 THURSDAY, APRIL 20, 1978   16

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE BIOMASS

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=164   MS=122933

GROUPING	MEAN	N	CONT
A	1067.930000	36	0
B	649.786593	182	1

GENERAL LINEAR MODELS PROCEDURE

MEANS

HEIGHT	SOIL	N	DBIO	LBIO	BIOMASS
3	CL	15	161.506667	571.72267	733.22933
3	SA	17	146.743529	628.20706	774.95059
3	SI	18	141.477778	666.62889	808.10667
6	CL	15	191.421333	740.34133	931.76267
6	SA	18	145.473333	618.89333	764.36667
6	SI	17	89.967059	503.47765	593.44471
9	CL	17	161.729412	677.56235	839.29176
9	SA	18	196.413333	406.60000	603.01333
9	SI	18	193.166667	494.84444	688.01111
12	CL	18	175.586667	470.27111	645.85778
12	SA	17	236.084706	353.44471	589.52941
12	SI	17	189.592941	342.00000	531.59294
24	CL	2	438.160000	1181.04000	1619.20000
24	SA	2	187.600000	636.12000	823.72000
24	SI	2	259.420000	897.56000	1156.98000
36	CL	2	314.500000	519.08000	833.58000
36	SA	4	290.200000	274.36000	564.56000
36	SI	1	386.320000	462.08000	848.40000

HEIGHT	MON	N	DBIO	LBIO	BIOMASS
3	F	17	229.992941	606.658824	836.65176
3	J	18	74.853333	620.582222	695.43556
3	O	15	147.034667	651.472000	798.50667
6	F	17	162.098824	681.317647	843.41647
6	J	16	45.180000	553.755000	598.93500
6	O	17	208.277647	609.520000	817.79765
9	F	18	237.308889	527.355556	764.66444
9	J	17	135.663529	495.430588	631.09412
9	O	18	176.888889	546.102222	722.99111
12	F	18	202.113333	431.426667	633.54000
12	J	16	153.132500	319.105000	472.23750
12	O	18	239.384444	412.004444	651.38889
24	O	6	295.060000	904.906667	1199.96667
36	F	1	31.000000	266.000000	297.00000
36	O	6	357.520000	388.613333	746.13333

HEIGHT	CONT	N	DBIO	LBIO	BIOMASS
3	0	6	265.360000	631.813333	897.17333
3	1	44	133.422727	624.201818	757.62455
6	0	6	422.140000	752.400000	1174.54000
6	1	44	101.964545	597.498182	699.46273
9	0	6	280.300000	798.760000	1079.06000
9	1	47	171.915745	488.340426	660.25617
12	0	6	500.800000	809.906667	1310.70667
12	1	46	160.701739	335.391304	496.09304
24	0	6	295.060000	904.906667	1199.96667

C6

GENERAL LINEAR MODELS PROCEDURE

MEANS

HEIGHT	CONT	N	DBIO	LBIO	BIOMASS
36	0	6	357.520000	388.613333	746.13333
36	1	1	31.000000	266.000000	297.00000

SOIL	MON	N	DBIO	LBIO	BIOMASS
CL	F	24	230.660000	647.013333	877.673333
CL	J	21	71.796190	537.066667	608.862857
CL	O	24	236.068333	677.413333	913.481667
SA	F	24	177.425000	502.233333	679.658333
SA	J	23	140.525217	497.568696	638.093913
SA	O	29	231.302069	483.412414	714.714483
SI	F	23	209.222609	514.685217	723.907826
SI	J	23	90.732174	471.133913	561.866087
SI	O	27	177.082963	550.521481	727.604444

C8

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LDEN

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	53	2259700.93023256	42635.86660416	3.26	0.0001	0.517952	48.5817
ERROR	161	2103060.00000000	13062.48447205		STD DEV		LDEN MEAN
CORRECTED TOTAL	214	4362760.93023256			114.29122658		235.25581395

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	414356.65658348	6.34	0.0001	5*	475590.11525750	7.28	0.0001
SOIL	2	68698.03919539	2.63	0.0752	2*	129330.08001328	4.95	0.0082
HEIGHT*SOIL	10	243411.85536872	1.86	0.0539	10*	318415.27455529	2.44	0.0099
MON	2	162962.93554623	6.24	0.0025	2*	71615.30707950	2.74	0.0675
HEIGHT*MON	7	76085.27303372	0.83	0.5634	6*	54637.23860699	0.70	0.6523
SOIL*MON	4	138428.92204153	2.65	0.0353	4*	106244.08450204	2.03	0.0922
HEIGHT*SOIL*MON	12	83583.91508015	0.53	0.8907	12	66891.07264410	0.43	0.9511
CONT	1	402107.82051282	30.78	0.0001	1*	436715.26479751	33.43	0.0001
HEIGHT*CONT	3	259000.58255232	6.61	0.0004	3*	160781.14537221	4.10	0.0079
SOIL*CONT	2	309321.24568490	11.84	0.0001	2*	250640.94531464	9.59	0.0001
HEIGHT*SOIL*CONT	5	101743.68458330	1.56	0.1738	5	101743.68458330	1.56	0.1738
MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
HEIGHT*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
SOIL*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
HEIGHT*SOIL*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.

* NOTE: OTHER TYPE IV TESTABLE HYPOTHESES EXIST WHICH MAY YIELD DIFFERENT SS.

C22

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LDEN

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=161   MS=13062.5

GROUPING	MEAN	N	WEIGHT
A	316.666667	6	24
A			
A	264.800000	50	3
A			
A	263.018868	53	9
A			
A	242.800000	50	6
B	175.510204	49	12
B			
B	108.571429	7	36

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LDEN

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=161   MS=13062.5

GROUPING		MEAN	N	SOIL
	A	252.058824	68	CL
	A			
B	A	245.205479	73	SI
B				
B		210.000000	74	SA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LDEN

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=161   MS=13062.5

GROUPING	MEAN	N	MON
A	260.512821	78	O
A			
A	241.408451	71	F
B	198.787879	66	J

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   12:08 THURSDAY, APRIL 20, 1978   23

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE LDEN

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=161   MS=13062.5

GROUPING	MEAN	N	CONT
A	318.857143	35	0
B	219.000000	180	1

GENERAL LINEAR MODELS PROCEDURE

MEANS

HEIGHT	SOIL	N	LDEN
3	CL	15	216.000000
3	SA	17	263.529412
3	SI	18	306.666667
6	CL	15	262.666667
6	SA	18	250.000000
6	SI	17	217.647059
9	CL	17	336.470588
9	SA	18	185.555556
9	SI	18	271.111111
12	CL	17	192.941176
12	SA	15	156.000000
12	SI	17	175.294118
24	CL	2	330.000000
24	SA	2	260.000000
24	SI	2	360.000000
36	CL	2	150.000000
36	SA	4	90.000000
36	SI	1	100.000000

HEIGHT	MON	N	LDEN
3	F	17	260.000000
3	J	18	250.000000
3	O	15	288.000000
6	F	17	258.823529
6	J	16	212.500000
6	O	17	255.294118
9	F	18	256.666667
9	J	17	196.470588
9	O	18	332.222222
12	F	18	198.888889
12	J	15	125.333333
12	O	16	196.250000
24	O	6	316.666667
36	F	1	120.000000
36	O	6	106.666667

HEIGHT	CONT	N	LDEN
3	0	6	256.666667
3	1	44	265.[illegible]
6	0	6	320.000000
6	1	44	232.272727
9	0	6	333.333333
9	1	47	228.51[illegible]
12	0	5	192.000000
12	1	44	150.[illegible]
24	0	6	316.666667

GENERAL LINEAR MODELS PROCEDURE

MEANS

HEIGHT	CONT	N	LDEN
36	0	6	106.666667
35	1	1	120.000000

SOIL	MON	N	LDEN
CL	F	24	250.833333
CL	J	21	189.523810
CL	O	23	310.434783
SA	F	24	235.000000
SA	J	22	210.909091
SA	O	28	187.857143
SI	F	23	236.260870
SI	J	23	195.652174
SI	O	27	293.333333

C28

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: EDEN

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	52	761121.17647059	14636.94570136	2.70	0.0001	0.545661	60.6170
ERROR	117	633740.00000000	5416.58119658		STD DEV		EDEN MEAN
CORRECTED TOTAL	169	1394861.17647059			73.59742656		121.41176471

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
HEIGHT	5	155234.64742912	5.73	0.0001	5*	108261.06730340	4.00	0.0023
SOIL	2	11264.56493890	1.04	0.3569	2*	6785.63847175	0.63	0.5363
HEIGHT*SOIL	10	91162.30209791	1.68	0.0927	10*	84158.53658537	1.55	0.1292
MON	2	136193.84132974	12.57	0.0001	2*	67460.61196661	6.23	0.0027
HEIGHT*MON	7	83676.67313403	2.21	0.0383	6*	9496.28665231	0.29	0.9396
SOIL*MON	4	9764.83104709	0.45	0.7717	4*	12541.81542219	0.58	0.6785
HEIGHT*SOIL*MON	12	56144.31649375	0.86	0.5854	11	20328.09181015	0.34	0.9740
CONT	1	123860.39215686	22.87	0.0001	1*	146409.67741936	27.03	0.0001
HEIGHT*CONT	3	27494.60784314	1.69	0.1709	3*	28826.27986348	1.77	0.1543
SOIL*CONT	2	23442.54294635	2.16	0.1194	2*	25934.34065934	2.39	0.0957
HEIGHT*SOIL*CONT	4	42882.45705362	1.98	0.1022	4	42882.45705362	1.98	0.1022
MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
HEIGHT*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
SOIL*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.
HEIGHT*SOIL*MON*CONT	0	0.00000000	.	.	0	0.00000000	.	.

* NOTE: OTHER TYPE IV TESTABLE HYPOTHESES EXIST WHICH MAY YIELD DIFFERENT SS.

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE DDEN

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=117   MS=5416.58

GROUPING		MEAN	N	HEIGHT
	A	157.647059	34	12
	A			
B	A	150.000000	6	24
B	A			
B	A	149.473684	38	9
B	A			
B	A	128.571429	7	36
B				
B		94.871795	39	6
B				
B		89.130435	46	3

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE DDEN

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=117   MS=5416.58

GROUPING	MEAN	N	SOIL
A	134.000000	50	CL
A			
A	120.000000	55	SI
A			
A	112.923077	65	SA

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   12:05 THURSDAY, APRIL 20, 1978   25

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE DDEN

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05   DF=117   MS=5416.58

GROUPING	MEAN	N	MON
A	151.612903	62	O
A			
A	128.196721	61	F
B	72.765957	47	J

STATISTICAL ANALYSIS SYSTEM 12:00 THURSDAY, APRIL 20, 1978 30

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE DDEN

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=117 MS=5416.58

GROUPING	MEAN	N	CONT
A	187.222222	36	0
B	103.731343	134	1

GENERAL LINEAR MODELS PROCEDURE

MEANS

HEIGHT	SOIL	N	DDEN
3	CL	13	81.538462
3	SA	15	84.000000
3	SI	18	98.888889
6	CL	10	140.000000
6	SA	16	88.750000
6	SI	13	67.692308
9	CL	11	178.181818
9	SA	15	130.666667
9	SI	12	146.666667
12	CL	12	123.333333
12	SA	13	166.153846
12	SI	9	191.111111
24	CL	2	190.000000
24	SA	2	100.000000
24	SI	2	160.000000
36	CL	2	210.000000
36	SA	4	85.000000
36	SI	1	140.000000

HEIGHT	MON	N	DDEN
3	F	17	121.176471
3	J	16	51.250000
3	O	13	93.846154
6	F	15	92.000000
6	J	11	36.363636
6	O	13	147.692308
9	F	13	184.615385
9	J	12	103.333333
9	O	13	156.923077
12	F	15	130.666667
12	J	8	120.000000
12	O	11	221.818182
24	O	6	150.000000
36	F	1	20.000000
36	O	6	146.666667

HEIGHT	CONT	N	DDEN
3	0	6	106.666667
3	1	40	86.500000
6	0	6	230.000000
6	1	33	70.303030
9	0	6	186.666667
9	1	32	142.500000
12	0	6	303.333333
12	1	28	126.428571
24	0	6	150.000000

GENERAL LINEAR MODELS PROCEDURE

MEANS

HEIGHT	CONT	N	DDEN
55	0	6	146.666667
55	1	1	20.000000

SOIL	MON	N	DDEN
CL	F	21	134.285714
CL	J	11	67.272727
CL	O	18	174.444444
SA	F	22	121.818182
SA	J	19	80.000000
SA	O	24	130.833333
SI	F	18	128.888889
SI	J	17	68.235294
SI	O	20	156.000000

APPENDIX D

MARSH SMOTHERING PLANT INVASION
2 x 2 FREQUENCY TABLES

Legend for Variable Codes

Inv = Number code of invading species (see Table 25).

Height = Enclosure height

3 = 8 cm

6 = 15 cm

9 = 23 cm

12 = 30 cm

24 = 61 cm

36 = 91 cm

Soil = Dredged Material type

SA = Sand

SI = Sand and Clay

CL = Clay

Mon = Month of Deposition

F = February 1976

J = July 1976

O = November 1976

PART 1

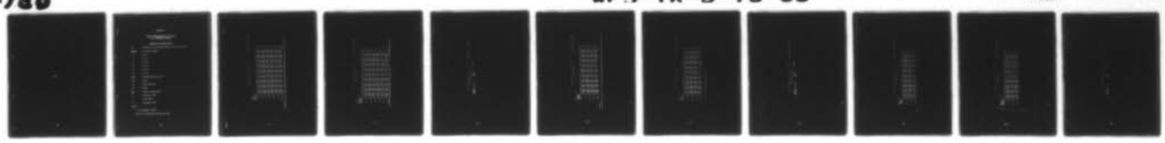
2 x 2 Frequency tables

Data of experimental enclosures only.

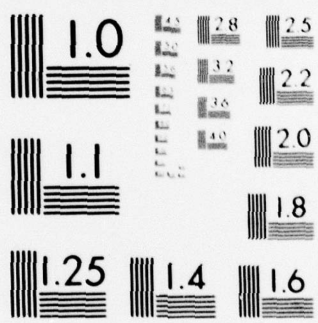
AD-A063 366 GEORGIA UNIV BRUNSWICK MARINE EXTENSION SERVICE F/G 13/2
THE EFFECTS OF SMOTHERING A 'SPARTINA ALTERNIFLORA' SALT MARSH --ETC(U)
JUL 78 R J REIMOLD, M A HARDISKY, P C ADAMS DACW21-75-C-0074

UNCLASSIFIED WES-TR-D-78-38 NL

6 OF 6
AD
A063366



END
DATE
FILMED
3-79
DDC



MICROCOPY RESOLUTION TEST CHART

PART 1

APPENDIX D

MARSH SMOTHERING PLANT INVASION
2 x 2 FREQUENCY TABLES

Legend for Variable Codes

Inv = Number code of invading species (see Table 25).

Height = Enclosure height

3 = 8 cm

6 = 15 cm

9 = 23 cm

12 = 30 cm

24 = 61 cm

36 = 91 cm

Soil = Dredged Material type

SA = Sand

SI = Sand and Clay

CL = Clay

Mon = Month of Deposition

F = February 1976

J = July 1976

O = November 1976

PART 1

2 x 2 Frequency tables

Data of experimental enclosures only.

STATISTICAL ANALYSIS SYSTEM

7:50 THURSDAY, DECEMBER 22, 1977 37

TABLE OF HEIGHT BY INV

HEIGHT / INV FREQUENCY CELL CHI2 PERCENT ROW PCT COL PCT	0	1	5	9	10	13	24	25	26	TOTAL
3	287 3.9 16.22 99.31 18.36	2 6.4 0.11 0.69 3.28	0 0.2 0.00 0.00 0.00	0 0.3 0.00 0.00 0.00	0 6.7 0.00 0.00 0.00	0 1.4 0.00 0.00 0.00	0 0.2 0.00 0.00 0.00	0 0.5 0.00 0.00 0.00	0 1.5 0.00 0.00 0.00	289 16.34
6	285 3.4 16.11 98.62 18.23	3 4.9 0.17 1.04 4.92	0 0.2 0.00 0.00 0.00	0 0.3 0.00 0.00 0.00	1 4.8 0.06 0.35 2.44	0 1.3 0.00 0.00 0.00	0 0.2 0.00 0.00 0.00	0 0.5 0.00 0.00 0.00	0 1.5 0.00 0.00 0.00	289 16.34
9	278 0.7 15.72 92.98 17.79	6 1.8 0.34 2.01 9.84	0 0.2 0.00 0.00 0.00	0 0.3 0.00 0.00 0.00	6 0.1 0.34 2.01 14.63	0 1.4 0.00 0.00 0.00	0 0.2 0.00 0.00 0.00	0 0.5 0.00 0.00 0.00	0 1.5 0.00 0.00 0.00	299 16.90
12	237 4.3 13.40 77.20 15.16	29 32.0 1.64 9.45 47.54	1 3.9 0.06 0.33 100.00	0 0.3 0.00 0.00 0.00	19 19.9 1.07 6.19 46.34	0 1.4 0.00 0.00 0.00	0 0.2 0.00 0.00 0.00	0 0.5 0.00 0.00 0.00	0 1.6 0.00 0.00 0.00	307 17.35
24	240 1.6 13.57 81.36 15.36	14 1.4 0.79 4.75 22.95	0 0.2 0.00 0.00 0.00	2 8.3 0.11 0.68 100.00	5 0.5 0.28 1.69 12.20	5 10.1 0.28 1.69 62.50	0 0.2 0.00 0.00 0.00	3 12.5 0.17 1.02 100.00	4 4.2 0.23 1.36 44.44	295 16.68
36	236 1.6 13.34 81.38 15.10	7 0.9 0.40 2.41 11.48	0 0.2 0.00 0.00 0.00	0 0.3 0.00 0.00 0.00	10 1.6 0.57 3.45 24.39	3 2.2 0.17 1.03 37.50	1 4.3 0.06 0.34 100.00	0 0.5 0.00 0.00 0.00	5 8.4 0.28 1.72 55.56	290 16.39
TOTAL	1563 88.36	61 3.45	1 0.06	2 0.11	41 2.32	8 0.45	1 0.06	3 0.17	9 0.51	1769 100.00

(CONTINUED)

TABLE OF HEIGHT BY INV

HEIGHT FREQUENCY CELL CHI2 PERCENT ROW PCT COL PCT	INV 23	29	30	31	32	33	34	35	36	TOTAL
3	0 0.7 0.00 0.00 0.00	0 0.3 0.00 0.00 0.00	0 2.8 0.00 0.00 0.00	0 1.8 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	0 3.3 0.00 0.00 0.00	0 2.8 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	289 16.34
6	0 0.2 0.00 0.00 0.00	0 0.3 0.00 0.00 0.00	0 2.8 0.00 0.00 0.00	0 1.8 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	0 3.3 0.00 0.00 0.00	0 2.8 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	289 16.34
9	0 0.7 0.00 0.00 0.00	0 0.3 0.00 0.00 0.00	3 0.0 0.17 1.00 17.65	6 9.2 0.34 2.01 54.55	0 0.7 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	0 3.4 0.00 0.00 0.00	0 2.9 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	299 16.90
12	1 3.9 0.06 0.33 100.00	2 7.9 0.11 0.65 100.00	7 5.6 0.40 2.28 41.18	5 5.0 0.28 1.63 45.45	0 0.7 0.00 0.00 0.00	4 15.7 0.23 1.30 100.00	2 0.6 0.11 0.65 10.00	0 3.0 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	307 17.35
24	0 0.7 0.00 0.00 0.00	0 0.3 0.00 0.00 0.00	6 1.5 0.34 2.03 35.29	0 1.8 0.00 0.00 0.00	4 16.7 0.23 1.36 100.00	0 0.7 0.00 0.00 0.00	7 4.0 0.40 2.37 35.00	5 1.7 0.28 1.69 29.41	0 0.7 0.00 0.00 0.00	295 16.68
36	0 0.2 0.00 0.00 0.00	0 0.3 0.00 0.00 0.00	1 1.1 0.06 0.34 5.88	0 1.8 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	11 14.2 0.62 3.79 55.00	12 30.5 0.68 4.14 70.59	4 17.1 0.23 1.38 100.00	290 16.39
TOTAL	1 0.06	2 0.11	17 0.96	11 0.62	4 0.23	4 0.23	20 1.13	17 0.96	4 0.23	1769 100.00

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	354.939	DF= 35 PROB=0.0001
PHI	0.448	
CONTINGENCY COEFFICIENT	0.409	
CRAMER'S V	0.200	

STATISTICAL ANALYSIS SYSTEM 7:50 THURSDAY, DECEMBER 22, 1977 40

TABLE OF SOIL BY INV

SOIL INV

FREQUENCY CELL CHI2 PERCENT ROW PCT COL PCT	0	1	5	4	10	13	24	25	26	TOTAL
CL	499 1.5 28.21 33.58 31.93	19 0.1 1.07 3.18 31.15	0 0.3 0.00 0.00 0.00	1 0.2 0.06 0.17 50.00	33 26.5 1.87 5.53 80.49	2 [illegible] 0.11 0.34 25.00	0 0.3 0.00 0.00 0.00	1 0.0 0.06 0.17 33.33	2 0.4 0.11 0.34 22.22	597 33.75
F	1 0.0 0.06 100.00 0.06	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	1 0.06
SA	537 0.9 30.36 92.11 34.36	18 0.2 1.02 3.09 29.51	0 0.3 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	1 11.6 0.06 0.17 2.44	4 0.7 0.23 0.69 50.00	1 1.4 0.06 0.17 100.00	0 1.0 0.00 0.00 0.00	6 3.1 0.34 1.03 66.67	583 32.96
SI	526 0.1 29.73 92.44 33.65	24 0.7 1.36 4.22 39.34	1 1.3 0.06 0.18 100.00	1 0.2 0.06 0.18 50.00	7 3.2 0.40 1.23 17.07	2 0.2 0.11 0.35 25.00	0 0.3 0.00 0.00 0.00	2 1.0 0.11 0.35 66.67	1 1.3 0.06 0.18 11.11	569 32.24
TOTAL	1563 88.36	61 3.45	1 0.06	2 0.11	41 2.32	8 0.45	1 0.06	3 0.17	9 0.51	1769 100.00

(CONTINUED)

STATISTICAL ANALYSIS SYSTEM 7:53 THURSDAY, DECEMBER 22, 1977 41

TABLE OF SOIL BY INV

SOIL / INV FREQUENCY CELL CHI2 PERCENT ROW PCT COL PCT	28	29	30	31	32	33	34	35	36	TOTAL
CL	1 1.3 0.06 0.17 100.00	2 2.6 0.11 0.34 100.00	17 22.1 0.96 2.85 100.00	11 14.3 0.62 1.84 100.00	4 5.2 0.23 0.67 100.00	0 1.3 0.00 0.00 0.00	1 4.5 0.06 0.17 5.00	4 0.5 0.23 0.67 23.53	0 1.3 0.00 0.00 0.00	597 33.75
[illegible]	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	0 0.0 0.00 0.00 0.00	1 0.06
SA	0 0.3 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	0 5.6 0.00 0.00 0.00	0 3.6 0.00 0.00 0.00	0 1.3 0.00 0.00 0.00	4 5.5 0.23 0.69 100.00	0 6.6 0.00 0.00 0.00	8 1.0 0.45 1.37 47.06	4 5.5 0.23 0.69 100.00	583 32.96
ST	0 0.3 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	0 5.7 0.00 0.00 0.00	0 3.7 0.00 0.00 0.00	0 1.3 0.00 0.00 0.00	0 1.3 0.00 0.00 0.00	19 33.0 1.07 3.23 95.00	5 0.1 0.28 0.85 29.41	0 1.3 0.00 0.00 0.00	588 33.24
TOTAL	1 0.06	2 0.11	17 0.96	11 0.62	4 0.23	4 0.23	20 1.13	17 0.96	4 0.23	1769 100.00

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   7:50 THURSDAY, DECEMBER 22, 1977 42

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	178.942	DF= 51	PROB=0.0001
PHI	0.318		
CONTINGENCY COEFFICIENT	0.303		
CRAMER'S V	0.184		

STATISTICAL ANALYSIS SYSTEM — 7:50 THURSDAY, DECEMBER 22, 1977

TABLE OF NPN BY INV

NPN / INV FREQUENCY CELL CHI2 PERCENT ROW PCT COL PCT	0	1	5	8	10	13	24	25	26	TOTAL
F	563 1.8 31.83 83.53 36.02	21 0.2 1.19 3.12 34.43	0 0.4 0.00 0.00 0.00	1 0.1 0.06 0.15 50.00	24 4.5 1.36 3.56 58.54	5 1.3 0.28 0.74 62.50	1 1.0 0.06 0.15 100.00	0 1.1 0.00 0.00 0.00	8 6.1 0.45 1.19 88.89	674 38.10
J	607 1.2 34.31 92.39 38.84	27 0.8 1.53 4.11 44.26	1 1.1 0.06 0.15 100.00	0 0.7 0.00 0.00 0.00	11 1.2 0.62 1.67 26.83	2 0.3 0.11 0.30 25.00	0 0.4 0.00 0.00 0.00	0 1.1 0.00 0.00 0.00	1 1.6 0.06 0.15 11.11	657 37.14
[illegible]	393 0.1 22.22 89.73 25.14	13 0.3 0.73 2.97 21.31	0 0.2 0.00 0.00 0.00	1 0.5 0.06 0.23 50.00	6 1.7 0.34 1.37 14.63	1 0.5 0.06 0.23 12.50	0 0.2 0.00 0.00 0.00	3 6.5 0.17 0.68 100.00	0 2.2 0.00 0.00 0.00	438 24.76
TOTAL	1564 88.46	61 3.45	1 0.06	2 0.11	41 2.32	8 0.45	1 0.06	3 0.17	9 0.51	1769 100.00

(CONTINUED)

STATISTICAL ANALYSIS SYSTEM 7:53 THURSDAY, DECEMBER 22, 1977

TABLE OF MON BY INV

MON / INV FREQUENCY CELL CHI2 PERCENT ROW PCT COL PCT	28	29	30	31	32	33	34	35	36	TOTAL
[illegible]	1 1.0 0.06 0.15 100.00	2 2.0 0.11 0.30 100.00	14 8.7 0.79 2.08 82.35	6 0.8 0.34 0.89 54.55	4 4.3 0.23 0.59 100.00	4 4.3 0.23 0.59 100.00	1 5.8 0.06 0.15 5.00	15 11.2 0.85 2.23 88.24	4 4.3 0.23 0.59 100.00	674 38.30
[illegible]	0 0.4 0.00 0.00 0.00	0 0.7 0.00 0.00 0.00	3 1.7 0.17 0.46 17.65	1 2.3 0.06 0.15 9.09	0 1.5 0.00 0.00 0.00	0 1.5 0.00 0.00 0.00	2 4.3 0.11 0.30 10.00	2 2.9 0.11 0.30 11.76	0 1.5 0.00 0.00 0.00	657 37.33
[illegible]	0 0.3 0.00 0.00 0.00	0 0.5 0.00 0.00 0.00	0 4.3 0.00 0.00 0.00	4 0.6 0.23 0.91 36.36	0 1.1 0.00 0.00 0.00	0 1.0 0.00 0.00 0.00	17 29.3 0.96 3.88 85.00	0 5.7 0.00 0.00 0.00	0 1.1 0.00 0.00 0.00	429 24.38
TOTAL	1 0.06	2 0.11	17 0.96	11 0.62	4 0.23	4 0.23	20 1.13	17 0.96	4 0.23	1760 100.00

D10

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   55
7:53 THURSDAY, DECEMBER 22, 1977

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	137.736	DF= 16 PROB=0.0001
PHI	0.279	
CONTINGENCY COEFFICIENT	0.269	
CRAMER'S V	0.197	

D11